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ABSTRACT

An environment appropriate for activity-oriented science is one that contains sufficient work space, equipment, and materials for students to practice and master the essential elements. This publication was developed to aid Texas school administrators, teachers, and architects to upgrade existing science facilities or plan new ones for kindergarten to grade 12. Chapter titles are as follows: (1) Overview of the Science Program; (2) Elementary School Science Facilities; (3) Middle Junior High School Facilities; (4) High School Science Facilities; (5) Computers in the Science Laboratory; and (6) Sample Floor Plans for Science Facilities. The chapters give details on science equipment needed, safety features that are necessary, and characteristics of science instruction. Appendix A, "Conditions of Instruction," is a National Science Teachers Association document pertaining to recommended work conditions for science teachers. Appendix B outlines state laws and regulations that apply to safety in science education and lists addresses of organizations that can help improve the safety of the classroom. The last appendix contains a laboratory safety checklist for science teachers. (PR)

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Foreword

This publication, *Planning a Safe and Effective Science Learning Environment,* has been developed to aid Texas School administrators, teachers, and architects. It should be helpful in upgrading existing science facilities and in planning new ones, kindergarten-Grade 12, to meet the instructional requirements of Title 19, Chapter 75 of the Texas Administrative Code.

A group of public school science teachers, supervisors, and university educators developed the forerunner of this publication, now in its third revision. We hope these guidelines, presented in a question-and-answer format, will enhance the quality, effectiveness, and safety of activity-oriented science at all levels of instruction.

W.N. Kirby
Commissioner of Education

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Overview of the Science Program

Why teach science?

The goal of Texas schools is to prepare students for the present and to help them move into the future as responsible members of a changing, highly technological world. Science education plays an important role in meeting this goal, for even the average citizen today must have a basic understanding of the principles of science and the relationship between science and technology.

What is the emphasis of science instruction?

Effective science instruction today focuses on an integration of science process skills. These skills are reflected by the science essential elements. Required essential elements of instruction for science, kindergarten through Grade 12, are listed in Title 19, Chapter 75 of the Texas Administrative Code. They provide students with opportunities to develop skills necessary to gain concepts and to solve problems throughout their lives. Historically, science instruction has emphasized content. Today, scientific facts are so voluminous it would be impossible for any individual to learn them all in a lifetime. Furthermore, science content may become obsolete as scientific knowledge progresses through new frontiers. Required essential elements for science, kindergarten through Grade 12, are as follows:

- manipulative skills
- skills in acquiring data through the senses
- classification skills in ordering and sequencing data
- communication of oral and written data
- measurement skills
- drawing logical inferences, predicting outcomes, forming generalized statements
- relating objects and events to other objects and events
- applying defined terms
- identifying and manipulating experimental variables
- applying science in daily life

State Board of Education rules require that science in kindergarten-Grade 6 be activity oriented; that is, it must contain a balance of content and student manipulative activities from the life, earth, and physical sciences. In Grades 7-12, State Board rules specify that science courses be laboratory oriented. To be considered laboratory oriented, science courses in Grades 7-12 must devote 40 percent of the instructional time to student laboratory/field activities.

In developing activities and designing laboratory facilities, educators must make a conscious effort to follow the letter and spirit of various state laws and regulations that relate to eye protection and to the use, storage, and disposal of hazardous chemicals. For particulars, see Selective Safety Directives, Appendix B.

What kind of environment is necessary for mastery of the essential elements?

An environment appropriate for activity-oriented science is one that contains sufficient work space, equipment, and materials for students to practice and master the essential elements. The equipment and materials needed will be determined by the types and levels of activities conducted. Science teachers develop, plan, and conduct the laboratory activities, and they should also be involved in designing laboratory facilities.

The environment of the science classroom should be flexible enough to accommodate a variety of activities ranging from observing the behavior of guppies to testing for starch in foods. Flexibility is also important in the optimum use of individual activities, small-group activities, and large-group activities.

What are the expected outcomes of a successful science program?

Effective science teaching in a proper laboratory environment can contribute to students' development of the following:

- curiosity leading to a satisfying understanding of our scientific/technological world and to providing a reasonable explanation of scientific phenomena
- safety practices in the workplace
- capacity for objective judgment, critical thinking, and decision making
- basis of scientific knowledge appropriate for future needs
- awareness of science and technology-related occupations
- appreciation of the historical development of science
- scientific literacy that enables students to deal with science-related issues

What constitutes laboratory instruction?

State Board rules specify that science courses in Grades 7-12 shall devote a minimum of 40 percent of the instructional time to student laboratory/field activities. **A laboratory/field activity is one in which students are actively engaged in manipulating equipment and/or materials, acquiring data through the senses (observing, examining, exploring, etc.), measuring quantities, etc.** In the secondary sciences, laboratory instruction has several important functions. It provides the means for introducing students to abstract ideas through concrete experiences. Research indicates that when a concept is presented in concrete terms, understanding of that concept is enhanced for students in all stages of cognitive development. Manipulative experiences are especially important for students still operating in the concrete stage. Teachers can present concepts in concrete form by simply involving students in three-dimensional model-building exercises, in introductory activities emphasizing fact gathering and generalizing, and in activities verifying a concept or principle.

In Grades 9-12, teacher demonstration is not considered laboratory/field activity although it is an important part of the teaching of science. The 40 percent of instructional time devoted to laboratory/field activities should be a cumulative average for the course. Teachers need not be concerned that certain units do not lend themselves to laboratory activities, because other units will require more than 40 percent laboratory time to be taught effectively. For example, in Chemistry I, atomic structure is a unit that does not lend itself to 40 percent laboratory time. However, the time will be made up during the unit on gas laws which may require a large percentage of laboratory time. The percentage of laboratory time should be based upon the time allotted to prelaboratory activities, the actual laboratory activity, and postlaboratory analysis.

With regard to field studies, the time that students are actually engaged on site is considered part of the laboratory time requirement. Travel time may or may not constitute a portion of the laboratory/field time. If the students are academically engaged, travel time may count toward the 40 percent laboratory time requirement. For example, while walking to a campus area for fieldwork, students may be asked to identify species of plants noted along the way. This activity would be considered academically engaged time and would constitute a portion of the laboratory time requirement. Teachers are encouraged to make use of the school campus and surrounding natural areas for providing a variety of opportunities for students to practice science process skills—observing, measuring, classifying, communicating, making inferences and predictions, and experimenting. Local community resources should also be used. For example, museums, zoological parks and aquaria, humane shelters, energy-generating plants, waste water treatment plants, planetaria, and private industry have educational programs that relate to science lessons.

Students using computers instead of doing actual activities in a science laboratory raises questions in regard to the 40 percent rule. Computer activity may be considered laboratory time if it is a simulation of an actual activity not easily conducted because of safety, equipment concerns, or time factors. Computer interphasing with measurement devices (i.e., temperature probes, pH probes) would be considered a laboratory activity as long as every student or small group is responsible for obtaining data

from the computer-managed equipment. The teachers' and students' use of the computer program as an introductory activity or demonstration or as a tool for drill and practice is not considered part of laboratory activities.

What are some types of laboratory activities?

There are several types of laboratory activities that emphasize different skills and objectives. Teachers of quality laboratory courses use each type of activity as appropriate. Types of laboratory activities include:

- verification activities

  These activities allow students to experience abstract concepts and phenomena in a concrete manner. Verification activities follow the initial presentation of the concept. For example, after an explanation of Boyle's law, the students observe the relationship in the laboratory.

- guided inquiry activities

  These activities allow students to determine relationships in their data and to draw their own conclusions. Students do not know the results of the activity prior to conducting it. Guided inquiry activities precede the presentation of the concept. For example, students collect volume data as they vary the pressure of a gas and draw a conclusion about the relationship from their data.

- inquiry activities

  Two categories of inquiry activities are teacher-initiated activities and student-initiated activities. In the teacher-initiated inquiry activity, the teacher presents students with a problem; the students are expected to develop research designs to test a hypothesis related to the problem. In the student-initiated activity, the student is expected to isolate the problem and develop the research design to test a formulated hypothesis.

- exploratory activities

  These activities allow students to observe and describe new materials and phenomena prior to receiving instruction. For example, students are asked to observe various protozoans and describe their movement. Exploratory activities tend to be unstructured with no specific procedure and require only a few minutes to complete.

- skill development activities

  These activities have as their major objective the teaching of a manipulative laboratory skill. For example, an activity in which the student weighs various objects using a triple-beam balance teaches a skill. These skills may be integrated with another type of activity. However, this forces the student to focus on two separate activities simultaneously. Complex skills are best taught separately from concepts.

- process development activities

  These activities provide opportunities for students to practice process skills and problem solving. For example, an activity in which the student makes a prediction and then tests that prediction facilitates the skill of predicting. Activities should be provided that allow students to practice all of the process skills reflected in the essential elements.

What lesson planning is appropriate for laboratory activities?

Lesson planning for laboratory instruction is crucial because the design of the activity is based on the objectives to be taught. Different types of activities such as verification, skill development, and inquiry emphasize different skill areas. For example, a teacher would plan a guided inquiry activity if an objective is to teach students to formulate a hypothesis. A verification activity would not be appropriate since verification activities follow the presentation of a concept and the outcome of the activity is known.

Teachers will find it helpful to plan laboratory/field activities using a prelaboratory, laboratory, and postlaboratory sequence. Prelaboratory instruction prepares the student for optimum involvement in the laboratory activity. Mixing reagents and setting up glassware and apparatuses are examples of prelaboratory activities. Teachers should always give general safety reminders and discuss specific safety concerns during prelaboratory instruction. The prelaboratory phase requires various amounts of instructional time depending on the type of activity. For example, an exploratory activity requires the teacher to give a minimum amount of information to the student. For a skill development activity, more information and modeling of the skill is needed prior to learning the skill.

The second phase, laboratory activity, involves students in the problem-solving process or provides concrete verification for a concept or principle. In this second phase, students manipulate equipment, materials, and/or variables; acquire data through the senses (observe, examine, explore, investigate, etc.); measure quantities; classify and categorize; group and label; etc. Teachers should present all types of laboratory activities.

The third phase, postlaboratory, provides a culminating experience for the laboratory/field activity in a variety of forms such as discussions, individual or class data analysis, student presentation of data and conclusions, and formal laboratory reports. During this phase, teachers emphasize the meaning and implications of the laboratory activity and encourage and guide students to suggest or discuss logical extensions and applications.

Elementary School Science Facilities

Why are science facilities important in the elementary school?

To understand science concepts, elementary school students need concrete experiences with scientific phenomena. Such experiences are required by Chapter 75 which specifies that science at the elementary school level be taught through a balance of content and activities. Students need sufficient time for involvement in these activities. Chapter 75 requires 100 minutes per week equivalent in Grades 1-3 and 225 minutes per week equivalent in Grades 4-6 be devoted to the teaching of science. Students also need to interact with classmates as they participate in science experiences.

Appropriate facilities creating a laboratory environment allow these needs to be met. In the elementary laboratory environment, students relate concepts and processes as they explore ideas. Initial science experiences should involve students in experimental investigation. Skills in basic processes should be introduced early and practiced as routine class activities. The basic processes require students to manipulate equipment and materials, acquire data through the senses, classify, communicate, measure, infer and predict, relate objects and events to other objects and events, apply defined terms based on observations, and identify and manipulate the conditions of investigations. To teach science as an investigation, adequate facilities and instructional materials are needed.

Science taught as an investigation:

- preserves the natural curiosity of children
- encourages peer interaction
- enhances creativity as students design experiments
- prepares students for the transition to later science courses
- helps students develop skills useful in other study areas
- prepares students for problem solving in later life

Within the informal, small-group activities of elementary school science, young students learn to appreciate and to enjoy science and the processes used by scientists. Students are stimulated by effective teaching to continue to learn science and to investigate their environment.

What facilities are necessary for elementary school science?

To comply with statutes and State Board of Education rules (§97.26 and §97.30 of Title 19, Part II of the Texas Administrative Code), science class sizes and instructional arrangement must support effective teaching and learning, and physical facilities must be safe, well designed for instruction, and conducive to learning. To provide for safe and effective science teaching and learning, the minimum specifications recommended for elementary school science are:

- 30 square feet of floor space per student, including storage and teacher preparation area
- moveable individual or two-student tables
- flat-topped desks and tables
- counter space including one sink
- water and waste water containers
- light control on all exits
- ample shelving and/or closets
- shelving or tables to store equipment in use
- provisions for audiovisual equipment
- bulletin boards and chalkboards
- electrical outlets spaced for convenient use
- aquaria, terraria, animal cages, incubators

An elementary science classroom/laboratory environment should facilitate the teaching of science process skills and the essential elements of observing, classifying, measuring, etc.

In addition to the minimum specifications, the following items are desirable and should be provided for an optimal program:

- protected garden in school yard
- simple greenhouse, may be portable
- vivarium
- work table with simple hand tools and simple machines
- a germination and growth chamber
- storeroom with shelves, file cabinets, and materials preparation areas

An elementary school classroom can be easily adapted to provide facilities for a quality science program. However, all science rooms in an elementary school do not have to meet these specifications as long as a sufficient number are equipped for a routine exchange among teachers.

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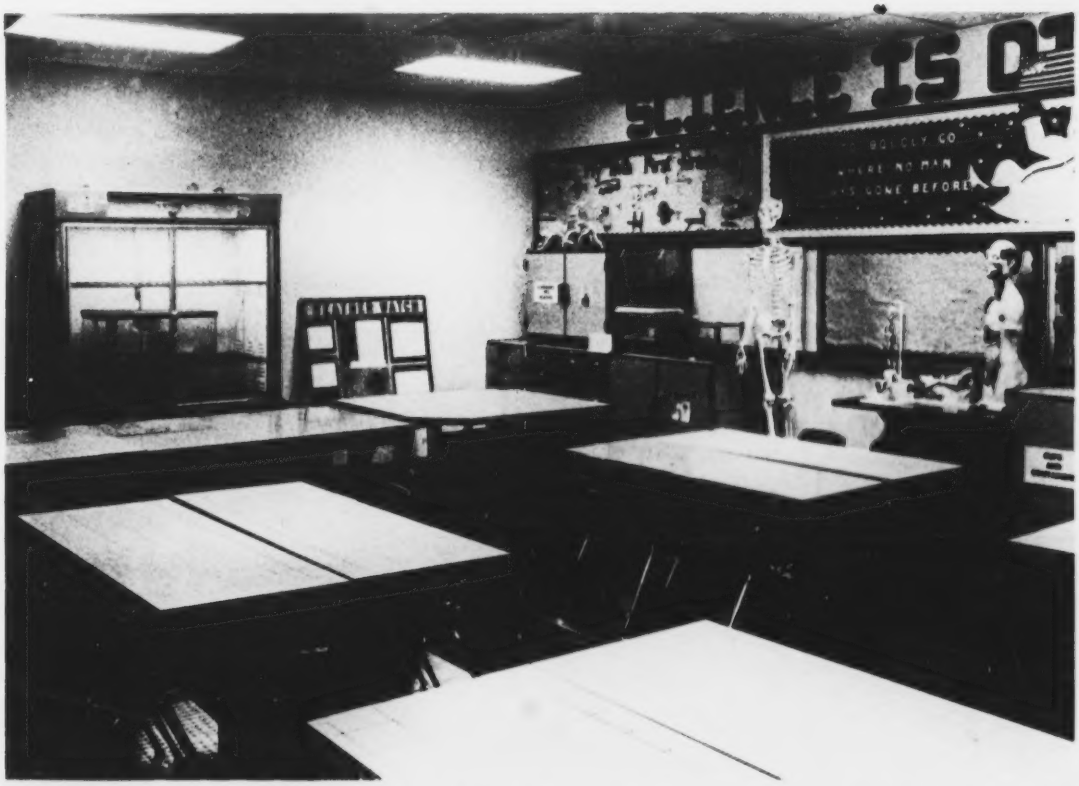

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Ample space for storage of materials and display of teaching models are necessary components of an elementary science classroom laboratory. An animal chamber to the left houses animals that can be used for observations and investigations.

What safety features are necessary in the elementary school science classroom?

Practice safety is a science subelement common to all levels, K-Grade 6. At the elementary school level, most of the activities and experiments do not require specific safety equipment. Rather, safety practices should be emphasized and practiced. Safety equipment includes a fire extinguisher, natural disaster plans, exit maps, and, when appropriate, splash-proof safety goggles and a means of sterilizing the goggles.

The following safety practices are recommended:

- discontinuation of experiences with food and the sense of taste in science class by the intermediate grades
- hand washing with soap and water following animal, plant, and field experiences
- humane handling and proper care of all animals used for study, including provision of sufficient food and water and clean and ample living space
- no display of poisonous or infectious plants and animals in the elementary classroom
- no teasing of animals
- return of native animals to their native environments after observation periods

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How can field trips be safe and effective?

Field trips are a valuable component of the science curriculum and contribute to the balance of content and activities required in Chapter 75.

Successful field trips are characterized by well-stated educational objectives, pretrip preparation, and effective follow-up activities and discussions. Every precaution should be taken to assure the safety of students and teaching personnel while on the trip. To make field trips safe and effective teaching strategies, teachers should:

- visit the site prior to the actual field trip; make thorough arrangements with site personnel or land owners
- integrate the essential elements of science, social studies, English language arts, mathematics, art, and others
- establish rules for safe conduct
- inform students of the potential dangers of the area
- instruct students to dress according to the demands of the terrain and weather
- provide adequate supervision
- have students use the "buddy system"
- take a well-stocked first-aid kit
- ensure that proper consent forms are completed, signed, and returned prior to departure
- avoid taking glass containers
- communicate appreciation to the staff of the facility through thank you notes from the students

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An elementary science classroom/laboratory with adequate equipment and materials provides for effective science learning. Equipment and materials pictured include a demonstration table, wagon for transporting materials, chalkboard center, storage areas, aquarium center, refrigerator, sink, and plant growth center.

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In the elementary grades, field experience may include:

- setting transects and counting organisms on the school campus
- gathering soil samples from various locations on the school campus
- working in a garden or outdoor site
- using playground equipment as examples of simple machines
- visiting local businesses or clinics within walking distance
- making excursions to businesses, manufacturing plants, museums
- taking trips to zoos, parks, creek beds, road cuts, waste water treatment centers, energy generating facilities

Middle/Junior High School Science Facilities

The organization of the middle/junior high school (usually Grades 6-8) provides opportunities for two science program designs—self-contained and departmentalized. The facilities necessary for a successful program in a self-contained classroom are different from those required in a departmentalized situation. In addition, laboratory designers should take into consideration the wide variation in student maturity and mental development of middle/junior high students.

Chapter 75 requires that students take one unit of science in Grade 6. One unit equals 45 minutes per day during a 175-day school year. In Grade 7, students are required to take one unit of life science; in Grade 8, one unit of earth science. Science courses in Grades 7 and 8 are to be laboratory oriented with teachers devoting a minimum of 40 percent of the instructional time to laboratory/ field activities. The laboratory requirement and the nature of the essential elements necessitate adequate science facilities in the middle/junior high school.

Regardless of the program format, the middle/junior high school science program should complement and continue the intellectual growth of the students by nurturing the development of science process skills begun in elementary school science.

What are the characteristics of science instruction in Grade 6?

The key to the design of Grade 6 laboratory facilities is flexibility. As sixth grade science is a general science course, a variety of activities are encountered from the biological, physical, and earth sciences. The variety of these activities requires a flexible arrangement of furniture. The self-contained classroom organization requires a more flexible arrangement than a departmentalized organization that confines science instruction to certain areas. Regardless of the organization, the Grade 6 science classroom requires more space than other courses as well as sources of water, heat, and electricity. In typical Grade 6 activities, students:

- construct and use electrical devices
- maintain plants and animals for behavioral and growth cycle studies
- use microscopes to observe the cellular composition of organisms
- investigate alternate energy sources
- investigate simple chemical elements and compounds
- design and conduct individual and small-group experiments, collections, and model building

What are the characteristics of science instruction in Grades 7 and 8?

For these grades, science education becomes more discipline-specific through the instruction of life and earth science.

Life Science

Life science is the study of life processes and of the relationships of living things to each other and to their environment. Water, gas, and electricity are needed to carry out the investigations. Students need flexible tables with flat surfaces for individual and group activities. In typical activities, students:

- use microscopes to study cell structure
- construct ecosystems and observe changes that occur over time
- observe behavior patterns
- manipulate growth factors in plants
- conduct experiments and test for substances related to conservation and pollution control

- conduct population studies
- observe life cycles of organisms
- measure life processes such as heart rate, respiration rate, and velocity of muscle contraction
- formulate life science hypotheses and design experiments to test hypotheses

Earth Science

Earth science involves the study of geology, oceanography, meteorology, and astronomy. Due to the scope of the course, a great variety exists in the activities performed. In the activities, students:

- practice weather, geological, and star mapping techniques
- identify and classify rocks and minerals
- investigate density and surface currents
- observe planetary motion and stellar bodies
- design and conduct an experiment to test an earth science hypothesis
- develop classification systems
- construct models to illustrate phenomena
- construct and use simple astronomical equipment
- test materials or erosion
- record and interpret weather data
- analyze the effects of wind and water currents on land formations
- experiment with temperature and pressure to explain natural forces
- interpret geological formations

Adequate working space and utility installations are needed for these activities. Table tops must be large enough to allow several students to set up equipment. Water, electricity, and gas are necessary. Storage should be adequate for the variety of equipment, materials, and teaching models typically used.

What facilities are necessary for middle/junior high school science?

Educators must organize and equip science rooms so that students may undertake laboratory activities individually or in small groups (two to four students) as a routine daily procedure. To comply with statutes and State Board of Education rules (§97.26 and §97.30 of Title 19, Part II of the Texas Administrative Code), science class sizes and instructional arrangement must support effective teaching and learning, and physical facilities must be safe, well designed for instruction, and conducive to learning.

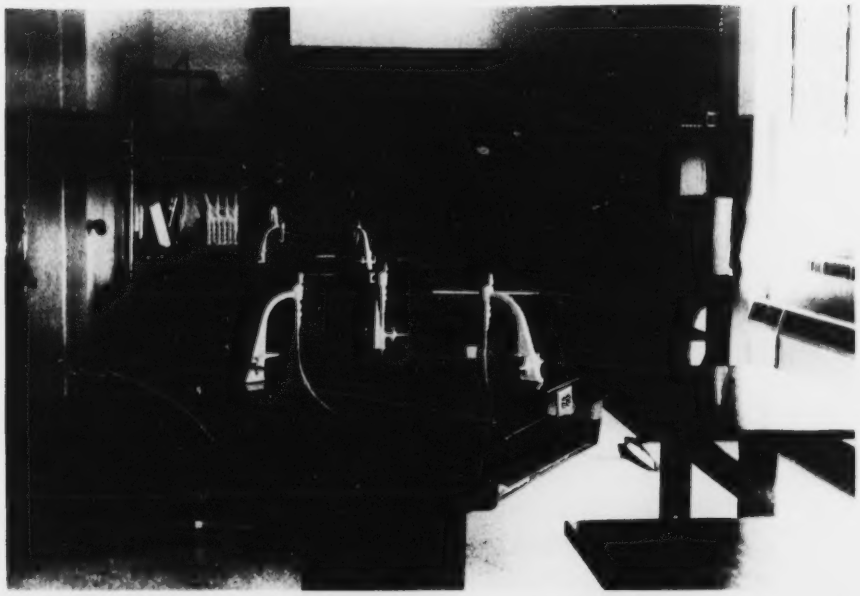
To provide for safe and effective science teaching and learning, the minimum specifications recommended for middle/junior high school are:

- 60 square feet of floor space per student, including storage and preparation areas
- two locking entrances into the laboratory room
- tables to permit individual and/or small group activities
- wall or island laboratory stations for four students (containing sink, heat source, running water, electrical service)
- six duplex electrical outlets properly spaced
- master controls for utilities located near the laboratory area
- ventilated storage for chemicals
- provisions for audiovisual materials (screens, audiovisual carts, etc.)
- stockroom and preparation area that is accessible to the classroom
- safety items (eye protection, fire extinguishers, fire blankets, eye-wash fountains, aprons, and first-aid kits)
- bookshelves for references and periodicals

Additional desirable laboratory items include:

Life Science

- refrigerator (explosion proof)
- plant growth center
- animal cages
- aquaria
- terraria



A renovated life science laboratory contains safety shower/eyewash fountain, teacher preparation area, storage area, and island service stations. The original available space consisted of a boys' restroom, a hallway, a small classroom, and a narrow walk-through storage area.

Earth Science

- access to a planetarium
- topographic maps
- telescope and related equipment
- photography equipment

What support areas are necessary for middle/junior high school science?

Stockroom

All stockrooms should have two lockable exits and should be ventilated. To prevent corrosion, teachers and students must store chemicals in a separate stockroom away from equipment items. Chemical stockrooms should have separate, continuous forced-air ventilation. Each stockroom should include laboratory carts properly designed for transporting equipment and materials of shelving. Storage cabinets should include several heights: more closely spaced shelving for small items and tall shelves for large equipment.

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An exhibit case in an earth science laboratory provides for continuous student exposure to instructional materials and serves as an effective storage area for rocks and other mineral specimens.

Preparation Area

Teachers of Grade 6 science, life science, and earth science should have a room to use for setting up laboratory lessons and for testing and repairing apparatus before its use in the classroom. The preparation area can be part of an equipment storeroom if it has a work surface and utility outlet. Regardless of its location, the preparation area should have locking doors. It should also contain a sink with a wall pegboard for drying glassware. A refrigerator is needed for storage of specimens, cultures, and special materials, as well as for making and storing ice. An explosion-proof refrigerator is required if it is used for storing chemicals. Utility master controls for the classroom areas and laboratory should be easily accessible to the teacher. A work surface with available electricity and hand tools is needed for maintaining equipment. The preparation of culture media necessitates a hot plate and a gas jet for using a gas burner.

Project Room

If possible, a school should have a special area where students can conduct experiments and projects in addition to the regular class work. This room should have lockers and table space for individual projects.

Nature Area

Each middle/junior high school should have an area of the school campus designated as a nature area. It should have both natural vegetation and animal life which are properly cared for. Students and/or teachers must provide the animals adequate food and water and ample living space. Proper supervision must ensure the safe use of the nature area and humane treatment of the animals. Students must exhibit proper hygiene such as washing their hands after handling and caring for specimens.

Field Trips

(See page 8 for guidelines on conducting safe and effective field trips.)

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High School Science Facilities

School districts must adequately furnish and equip secondary science classrooms to facilitate a laboratory approach to instruction. State Board of Education rule specifies that 40 percent of the instructional time be allocated for student laboratory/field investigations exclusive of teacher demonstration.

Laboratory experiences are critically important because research indicates that the concrete representation of an abstract idea facilitates the learning of that concept for students in all stages of mental development. Manipulative experiences are especially important for those students still operating in the concrete stage. When a concept is presented to students in concrete terms, understanding of that concept is enhanced. Putting a concept into concrete terms can be as simple as having students build a three-dimensional model, presenting introductory activities that emphasize fact gathering and generalizing, and having students participate in activities that verify the concept or process. Inquiry activities incorporate a laboratory discussion to make clear the concepts and/or principles involved. Verification (confirmatory) activities follow class discussion of the concept or principle and serve to reinforce student understanding.

For safety reasons and laboratory management considerations, science educators recommend that the the enrollment in science classes should be limited to a maximum of 24 students in any one class provided adequate laboratory space exists for this number. It should be noted that 24 is not an average enrollment but a maximum in any one class.

What are the general requirements for high school laboratories?

To comply with statutes and State Board of Education rules (§97.26 and §97.30 of Title 19, Part II of the Texas Administrative Code), science class sizes and instructional arrangement must support effective teaching and learning, and physical facilities must be safe, well designed for instruction, and conducive to learning. To provide for safe and effective science teaching and learning, the minimum specifications recommended for high school science are:

- one sink with water tap, heat source, and duplex electrical outlet for every four students (see Chemistry, page 20, for exceptions)
- five square feet of horizontal work surface per student
- adequate room ventilation to facilitate removal of noxious gases
- multipurpose (ABC) fire extinguisher in every science classroom
- clock with a sweep secondhand in each classroom
- a minimum of 60 square feet of floor space per student for laboratory/classroom and support areas
- safety equipment

What constitutes adequate ventilation for laboratories?

Adequate ventilation is especially important in secondary science facilities where noxious fumes can accumulate. The generation of small amounts of gases in common laboratory activities and the accumulation of fumes in chemical storage and preparation areas produce a potentially hazardous situation.

The ventilation system in the laboratory and stockroom should be a floor-to-ceiling forced system with the exhaust above the roof level. In the storage and preparation areas, the ventilation should be continuous. The standard for acceptable indoor ventilation of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers is determined by an outdoor air requirement of 10 cubic feet per minute per student per laboratory. Outdoor air is the air taken from the external atmosphere and, therefore, not previously circulated through the system. Laboratory fume hoods are designed for removal of gases generated under the hood. They are not adequate for room ventilation. A general room ventilation system or a laboratory table ventilation system is necessary to ensure the safety of the students and teachers.

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A fume hood in the laboratory provides adequate ventilation for special experiments, demonstrations, and chemical solution preparation. Island service stations with drawers underneath provide ample storage space. A floor-to-ceiling forced air ventilation system provides adequate ventilation system for the general laboratory area.

In the planning of new science facilities or the renovation of existing facilities, designers are cautioned to exhaust air directly to the outside from chemistry classrooms to prevent fumes from entering other classrooms and from deteriorating delicate air-conditioning equipment in a recycling process. A chemistry laboratory should have its own separate heating and cooling unit as a safety precaution. Other classes that use chemicals should be treated similarly.

What safety equipment is required and/or recommended?

Protective eye devices are required in chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids as defined by Section 21.909 of the Texas Education Code. State and federal regulations require school districts to furnish protective eye devices at no cost to students and teachers. Safety goggles that are chemical splash proof are required. Goggles that are shared by students must be sterilized between use.

The Texas Hazard Communication Act requires other safety equipment in all science laboratories where hazardous chemicals are stored and used. Required safety equipment includes fire extinguishers, fire blanket, eye-wash fountains, safety showers, exhaust fume hoods, and chemical spill control kits. Fire extinguishers and fire blankets are recommended in all science facilities.

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What are some typical activities and special features of the laboratory setting for the content areas?

Physical Science

Physical science is a laboratory-oriented course presenting investigations of physical phenomena designed to develop an understanding of the basic concepts of chemistry and physics.

Laboratory work stresses the generation of data and its interpretation. The techniques employed in physical science are designed to broaden students' understanding of the physical world. In typical activities, students:

- determine the relationship between volume and mass
- manipulate temperature and pressure
- study force and motion
- investigate electrical phenomena
- construct models such as the atom and a voltaic cell
- investigate the particle nature of matter
- design experiments to test hypotheses relating to physical science
- construct basic equipment such as force gauges, compasses, and electromagnets

7

A combination of island service stations of stand-up height and lecture seats allows for smooth transfer between lecture instruction and laboratory activities.

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A classroom/laboratory combination allows for flexibility and smooth transfer between activities and lecture instruction.

Facilities for physical science include:

- two locking entrances into the laboratory room
- stand-up height wall or island laboratory stations
- a water faucet and sink for every two students (for every four students if the laboratory tables are arranged as islands)
- one duplex electrical outlet for every two students
- one gas jet for every two students
- chemical-proof surface on laboratory tables
- exhaust hoods
- floor-to-ceiling forced ventilation
- noncorrosive sinks and plumbing
- special drums for hazardous chemical wastes

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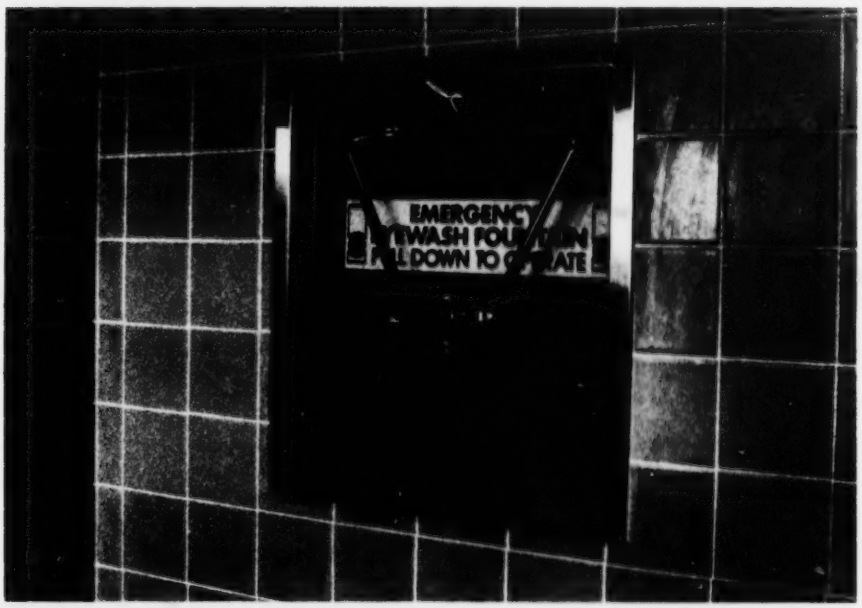
Safety equipment is especially critical for physical science laboratories due to the nature of the materials used. Safety items for physical science laboratories include:

- splash-proof safety goggles and sanitizing unit
- fire extinguishers and fire blankets
- eye-wash fountains (Portable eye-wash fountains are NOT adequate and should not be used as emergency equipment for laboratory students. Adequate eye-wash fountains must have the capacity of copiously washing the eyes for a minimum of 15 minutes.)
- safety showers (The flow of water should be between 30 and 60 gallons per minute under a pressure of 20 to 50 pounds per square inch. A safety shower should be located where no one in the laboratory would have to walk farther than 50 feet to reach it.)
- exhaust fume hoods
- Material Safety Data Sheets for every chemical stored or used (see Texas Hazard Communication Act, pages 54-55)
- chemical spill control kits



9

Wall-inset eyewash fountain saves floor space.

Biological Science

Laboratory work is necessary if students are to gain an understanding of life processes and how they apply in their lives. In typical laboratory activities in biology, students:

- grow plants and maintain animals*
- maintain aquaria and terraria
- construct display collections of biological specimens
- design experiments to test student-formulated hypotheses
- clarify biological processes operationally through manipulative activities
- observe the behavior of organisms
- develop proficiency with the use of the microscope
- prepare wet and dry-mount slides for microscopic viewing

*All animals used for study must be properly fed, given sufficient water to drink, provided with clean and ample living space, and handled humanely at all times.

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Facilities for biological science include:

- two locking entrances into the laboratory room
- laboratory stations containing sinks, gas, water, and electricity with chemical-proof surfaces and storage for supplies and equipment
- wall laboratory stations complemented by 30-inch student tables (adequate for most activities)

Facilities should be planned to allow for new equipment additions such as growth chambers, germinating beds, autoclaves, incubators, refrigerators, stoves, controlled environmental animal centers, greenhouses, and campus nature areas.

Safety items for the biological sciences include:

- splash-proof safety goggles and sanitizing unit
- fire extinguishers and fire blankets
- eye-wash fountains (Portable eye-wash fountains are NOT adequate and should not be used as emergency equipment for laboratory students. Adequate eye-wash fountains must have the capacity of copiously washing the eyes for a minimum of 15 minutes.)
- Material Safety Data Sheets for every chemical stored or used (see Texas Hazard Communication Act, pages 54-55)

10

Store microscopes and any sensitive equipment in display cases or cabinets away from corrosive chemicals.

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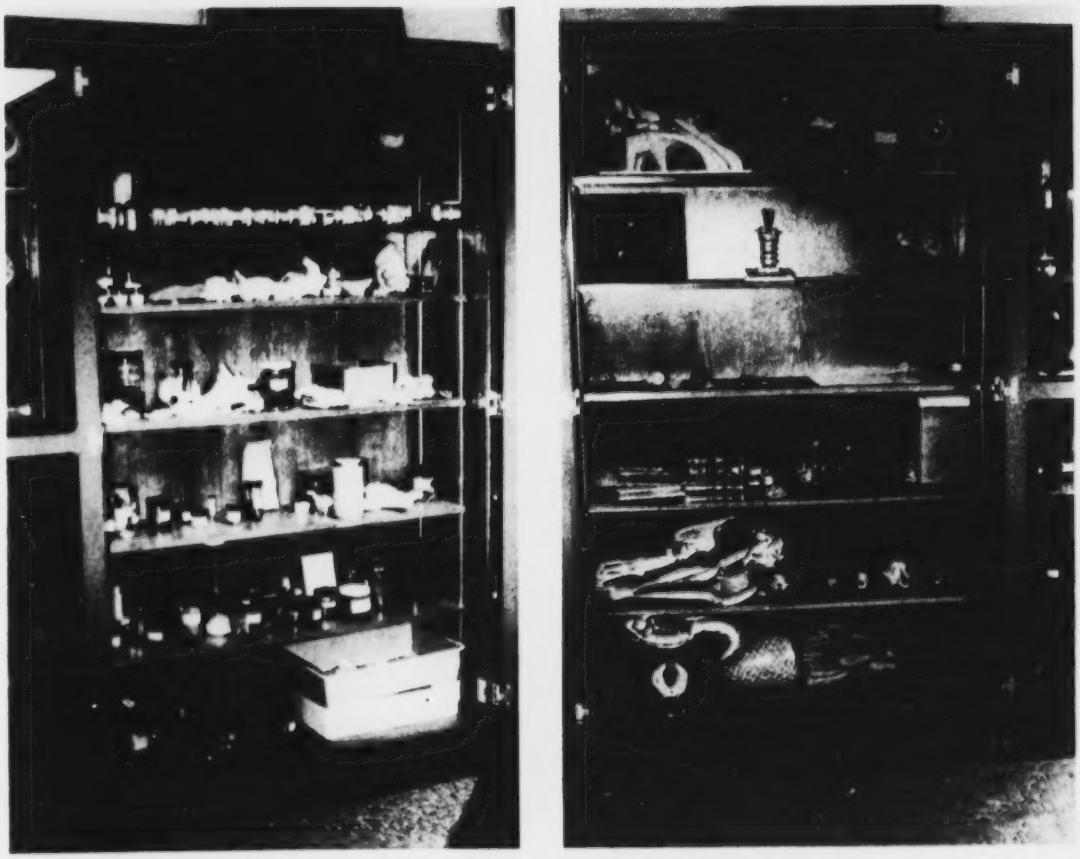

11

Use separate display cases or cabinets to store science specimens *(left)* and models *(right)*.

Chemistry

Chemistry is typically the first course in which students encounter a considerable number of abstract concepts. Laboratory investigations, involving characteristics and changes of matter, can be particularly helpful in developing these concepts. In typical activities, students:

- observe chemical reactions
- measure a variety of chemical quantities with appropriate instruments
- explore factors affecting the rate of chemical reactions
- use qualitative analysis schemes to identify unknown ions in solution
- observe the behavior of matter under various conditions of temperature and pressure
- clarify chemical processes operationally through student activity
- formulate hypotheses and design experiments to test them

Facilities for the chemistry laboratory include:

- two locking entrances into the laboratory room
- stand-up height wall or island laboratory stations
- a water faucet and sink for every two students (for four students if the laboratory tables are arranged as islands)
- one duplex electrical outlet for every two students

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- one gas jet for every two students
- chemical-proof surface on laboratory tables
- a fume hood
- floor-to-ceiling forced ventilation
- noncorrosive sinks and plumbing
- special drums for hazardous chemical wastes

Safety equipment is especially critical for chemistry laboratories due to the nature of the materials used. Federal and state laws (Standards for Eye Protection in Public Schools and Texas Hazard Communication Act) require certain items to be available in science laboratories where students and teachers use and store hazardous chemicals. In May 1985, the Texas Legislature enacted the Texas Hazard Communication Act. Since 1986, the Act has required that all school districts provide notice of the Act to employees, obtain Materials Safety Data Sheets for each hazardous chemical in the workplace, label hazardous chemicals appropriately, develop and maintain workplace chemical lists, and provide annual training for faculty, staff, and students. The training program should include information related to the following:

A. The acute and chronic effects of hazardous chemicals

As trainers discuss this component, they should use the OSHA definition of hazardous chemicals. According to OSHA, chemical hazards are classified as either physical hazards or health hazards. Physical hazards include combustible liquids, compressed gas, explosives, flammables, organic peroxides, phyrophorics, oxidizers, unstable chemicals, and water reactives. Health hazards include all chemicals for which there is statistically significant evidence, based on at last one study conducted in accordance with established scientific principles that acute or chronic effects may occur in exposed employees. Examples of health hazards are carcinogens, corrosives, sensitizers, heptotoxins (chemicals that are toxic to the liver), nephrotoxins (chemicals that are toxic to the kidneys), and hematopoietic toxins (chemicals that are toxic to the blood-forming tissues).

B. Interpreting chemical labels

Labels on chemical products may be teacher made or commercially purchased. In either case, a proper label should contain the following information: chemical name, common name or trade name; the physical and health hazards of the chemical, precautionary warning (Caution!, Danger!, Combustible!, Corrosive!, Explosive!, Flammable!, Toxic!, Poisonous!, Shock sensitive!, Carcinogen!, Mutagen!, Teratogen!, Causes burns!, Do not inhale vapors!, Avoid contact with skin!, Do not ingest!, Do not use in open air!); personal protective equipment required (full face-head, eye, hand, body, respiratory); emergency response measures (fire, explosion, ingestion, inhalation, and absorption); fire fighting equipment; spill clean-up, method of container disposal if contents are toxic, corrosive, or caustic; and the name, address, and phone number of the manufacturer or supplier.

C. Interpreting Material Safety Data Sheets (MSDS)

Trainers should encourage and explain the use of MSDS. Manufacturers and/or importers of chemical products are required by law to include these sheets with each product.

The sheets should contain:

1. the chemical and common name(s) of the hazardous chemical
2. the physical and chemical properties of the chemical
3. the physical and health hazards of the chemicals including the potential for fire, explosion, reactivity, signs and symptoms of exposure, and any medical conditions which are aggravated by the chemical
4. the OSHA permissible exposure limit (PEL), threshold limit used or recommended by the chemical manufacturer, importer, or employer preparing the MSDS

5. precautions for safe handling and use including storage information, fire and explosion information, appropriate hygienic practices, protective measures, control measures, work practices, waste disposal, and procedures for clean-up of spills and leaks
6. the primary route(s) of entry of the chemical and the date of preparation of the MSDS or the last change(s) to it
7. emergency and first-aid procedures
8. the name, address, and telephone number of the chemical manufacturer, importer, employer, or other responsible party involved in preparing or distributing the MSDS who can provide additional information on the hazardous chemical and appropriate emergency procedures should that become necessary

D. First-aid treatment

Trainers should discuss specific first-aid treatment for accidents involving chemicals: involuntary inhalation (vigorous ventilation in fresh air, artificial respiration, oxygen supply, etc.), ingestion (water supply, vomiting, etc.), skin exposure (flushing with plenty of water, removing contaminated clothing and shoes), and eye exposure (copious eye washing).

E. Workplace Chemical List (WCL)

A school campus is considered a workplace. Science teachers must compile and maintain a chemical list of all hazardous chemicals that are stored in the school. The list must contain the chemical name, the common name used, the nomenclature used in identifying the chemical name, the work area in which the hazardous chemical is normally used or stored, and the quantity in gallons or pounds. The workplace list must be updated as necessary and retained (in original updated form) on file for a period of 30 years.

School districts must annually file with the Texas Department of Health workplace chemical lists for all hazardous chemicals that are stored in the school in excess of 55 gallons or 500 pounds.

A $25 fee is required for each list; however, multiple workplaces having fewer than 25 items on the list can become consolidated and turned in as one list with one $25 fee. Failure to file the list or pay the fee is a serious violation subject to assessment of administrative penalties.

A written report should follow the Texas Hazard Communication Act training and education program informing the Texas Department of Health that training has taken place. The report is due within 30 days of completion of training. Furthermore, districts should inform the fire department of the names, addresses, and phone numbers of designated safety officers on each campus.

Section 7 of the Texas Hazard Communication Act makes the Material Safety Data Sheets (MSDS) the basic document that must be provided and followed in hazard communication.

Section 15 (Employee Rights) guarantees, among other things, that "... employees **shall** receive training on the hazards of the chemicals and on measures they can take to protect themselves from these hazards and **shall** be provided with appropriate personal protective equipment." Section 7 (Employee Education Program) also requires training on personal protective equipment.

Material Safety Data Sheets (MSDS) provided by chemical manufacturers or suppliers identify hazardous chemicals. Required safety items include:

- splash-proof safety goggles and sanitizing unit
- fire extinguishers and fire blankets
- eye-wash fountains (Portable eye-wash fountains are NOT adequate and should not be used as emergency equipment for laboratory students. Adequate eye-wash fountains must have the capacity of copiously washing the eyes for a minimum of 15 minutes.)

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Place safety equipment and supplies such as safety shower, eyewash fountain, goggles cabinet, sanitizer, first-aid cabinet, fire blanket, etc. in a location that is easily accessible to students and teachers.

- safety showers (The shower flow should be between 30 and 60 gallons of water per minute under a pressure of 20 to 50 pounds per square inch. A safety shower should be located in a place where no individual in the laboratory should have to walk further than 50 feet to reach the shower.)
- exhaust fume hoods
- Material Safety Data Sheets for every chemical stored or used (see Texas Hazard Communication Act, pages 54-55)
- chemical spill control kits

Physics

Investigations relating to the physical world and its behavior are a central part of physics instruction. Adequate space, facilities, and equipment are necessary to implement the emphasis on laboratory activities. In typical investigations, students:

- observe the motion of falling objects, constant velocity objects, and colliding objects
- conduct optical studies using light rays over a distance
- investigate the functions of electronic circuits
- formulate hypotheses and design experiments to test them
- observe wave phenomena through the use of ripple tanks and other devices
- measure physical quantities using the appropriate devices
- compare the electrical efficiency of appliances

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Laboratory facilities include:

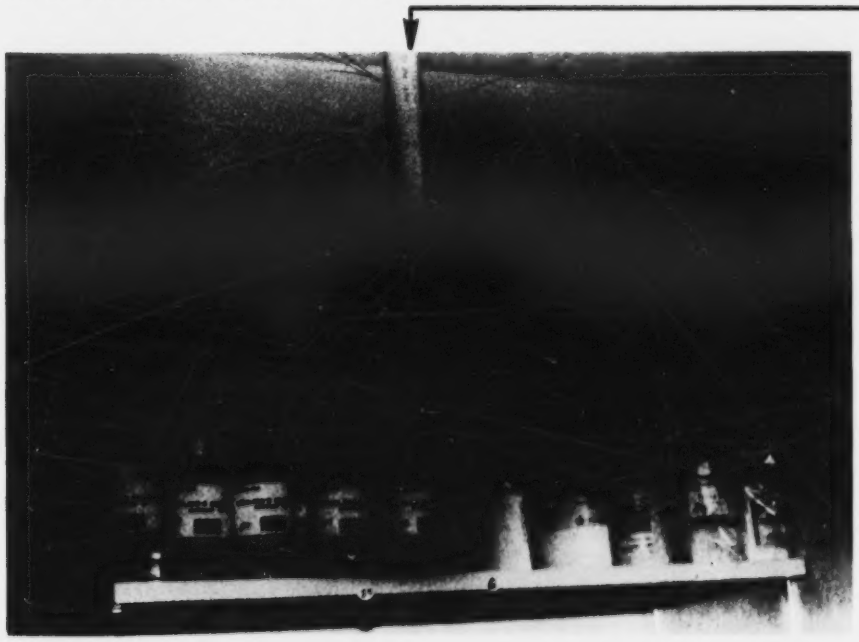
- two locking entrances into the laboratory room
- stand-up height laboratory stations (wall or island stations)
- gas and alternating current electrical outlets for every two students
- sink and water faucets per service unit
- portable direct current sources protected by circuit breakers
- noncorrosive surfaces

Safety equipment for the physics laboratory include:

- fire extinguishers and fire blankets
- splash-proof safety goggles and sanitizer
- eye-wash fountains

What support facilities are necessary for high school science laboratories?

A stockroom is necessary for the storage of chemicals, equipment, and supplies. However, delicate instruments and metal equipment must not be stored in close proximity to the chemicals due to their corrosive properties. Equipment may be damaged if stored near chemicals even in vented storerooms.



13

Chemical storage cabinets should be vented to the outside. This ventilation supplements the continuous floor-to-ceiling forced air ventilation in the general storage area.

Stockrooms for all areas should have the following common characteristics:

- two locking entrances into the stockroom
- for chemicals, separate storage with continuous forced-room ventilation. The storage of chemicals must be based on the chemical properties and the particular hazards of the substances rather than on simply the alphabetical order of the chemical names. Special consideration must be given to organic and inorganic chemicals, flammables, acids, poisons, and incompatible chemicals.

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Cabinets used to store flammables should be vented to the outside. This ventilation supplements continuous floor-to-ceiling forced air ventilation in the general storage area.

- adequate ventilation in all other support areas
- carts with raised edges for transporting equipment and materials
- wooden shelving with varied depths, or adjustable shelving
- cabinets for storing large items
- storage for audiovisual materials
- drawers, bins, or boxes for small-item storage

Preparation rooms furnish areas for teachers to set up and try out equipment and activities prior to their use in the classroom and to repair and service equipment. Provisions to consider in planning preparation rooms include:

- services (gas, water, electricity) as in classrooms
- refrigerator for storing perishable items such as stock solutions or biological materials
- autoclave or dishwasher for sterilizing glassware
- a cooking unit for preparing culture medium
- sink with hot water for cleaning labware
- master cut-off valves for all classroom utility services
- lockable doors
- work surface with electricity available
- distillation or demineralizing equipment
- adequate ventilation
- cabinets and shelving for storing special items

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Spacious well-ventilated storage with full shelving and preparation area allows for convenience and safety in preparing chemicals and setting up student activities. The safe storage of chemicals must be based on the chemical properties and the particular hazards of the substances rather than on simply the alphabetical order of the names of the chemicals.

16

Use explosion-proof refrigerators to store certain chemicals.

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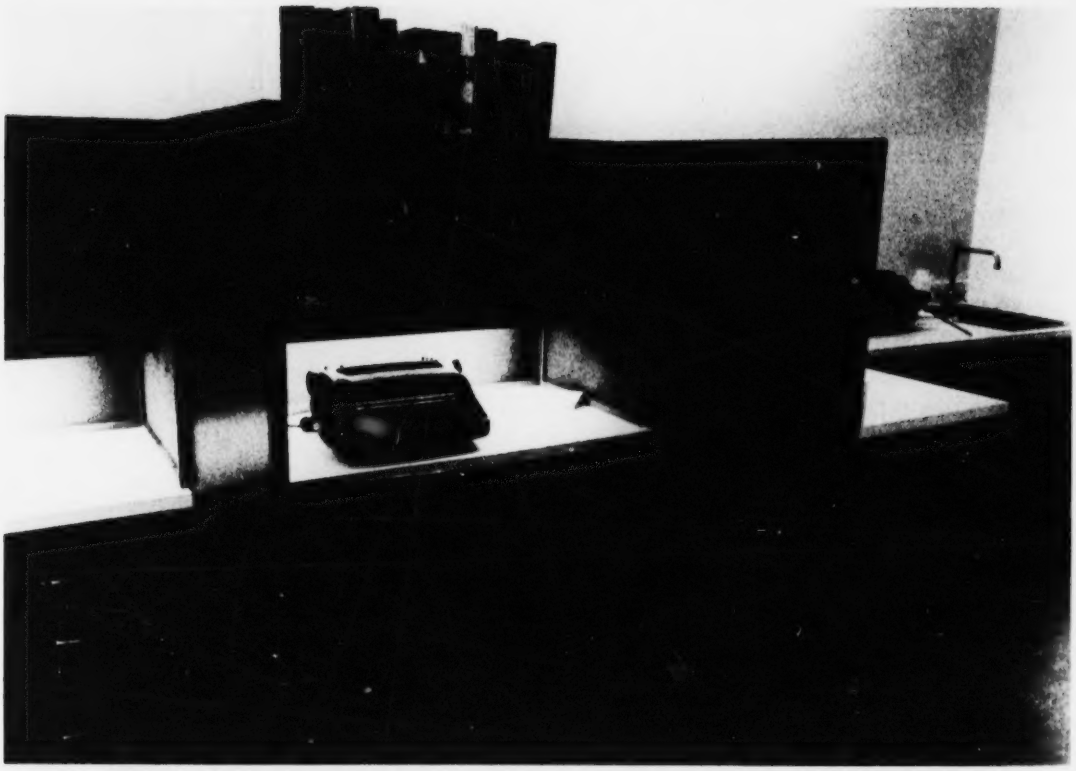

17

Teacher office area with locking gradebook drawers, book storage, and reading light allows for privacy and effective preparation.

Specialized Support Areas

The teaching of science is enhanced by special facilities such as greenhouses, vivaria, animal centers, outdoor nature areas, and planetariums. Greenhouses can provide plants for study and research. They can be purchased or built using wooden frames with polyethylene covering. An effective greenhouse requires controlled light, humidity, temperature, insects, and water. The vivarium is a combination of terrarium and aquarium and incorporates the best features of both. It can be used as a greenhouse or animal cage and is highly effective for providing an observation center for students.

An animal center should be well ventilated and should have humidity and temperature controls, floor drains, faucet connections, and wall surfaces that can be easily cleaned. Tables or counters should be provided for animal cages. Storage areas for food and a sink for cleaning utensils and feeding trays are necessary.

Outdoor nature areas can be most useful and convenient if they are part of the school campus. Ideally, they should contain a variety of environments—grasslands, trees, aquatic, and desert areas. However, any nature area can be a valuable asset if used properly for student observation, recording of data, and experimentation. Every school campus should have a designated nature area that is left undisturbed.

Access to a planetarium can enrich students' experiences. A portable planetarium provides a viable option instead of a permanent installation for districts with economic and/or space constraints. Public planetariums have excellent educational programs for all age groups; school districts are encouraged to take advantage of the services if one is located nearby.

Field Trips

(See page 8 for guidelines on conducting safe and effective field trips.)

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Computers in the Science Laboratory

The number of science teachers using computers in the classroom will increase as the quality and quantity of science courseware improves. More and more teachers will discover how valuable computers can be to them. For, in addition to being used to teach science concepts, a computer can be a tool in science laboratory investigations.

How can computers be used in the laboratory?

Computers assist students in such tasks as:

- repetitive calculations
- storage and display of data collected during a laboratory activity
- statistical analysis of collected data
- graphical analysis of collected data
- computer instrumentation for automated collection of data in the laboratory
- laboratory simulations when safety would otherwise be compromised

Where should the computer be located in the laboratory?

Because computer hardware and software are extremely susceptible to the corrosive effect of many common laboratory chemicals, the computer should be placed away from where chemicals are handled. Even so, students should have easy access to the computer. One solution would be to place the computer on a mobile table. This would be advantageous since occasions such as computerized instrumentation will arise when the computer requires temporary use at the laboratory table. Also, this solution is ideal when the computer must be shared among laboratories. Placement of the computer for laboratory group activities should allow for group seating and should not provide an obstacle for other students working in the laboratory.

An ideal location for the computer would be in a separate room directly off the laboratory and possibly shared between two laboratories. This would place the computer away from the student activity in the laboratory and the handling of chemicals. Using mobile tables would allow the computer to be brought into the laboratory as necessary.

18

A computer room provides an environment for laboratory simulations, storage and display of data collected during a laboratory activity, statistical analysis of collected data, etc. Individual computers may be moved on carts to the science classroom/laboratory for computer interfacing and other science applications.

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Sample Floor Plans for Science Facilities

On the following pages are several floor plans utilizing various types and configurations of laboratory furniture. These are presented as basic guidelines. Most are designed for 24 students. Adaptations of the floor plans may be made to fit individual educational programs. Although a floor plan may be labeled for a specific science discipline, by the addition or deletion of various items the room may be adapted to other sciences.

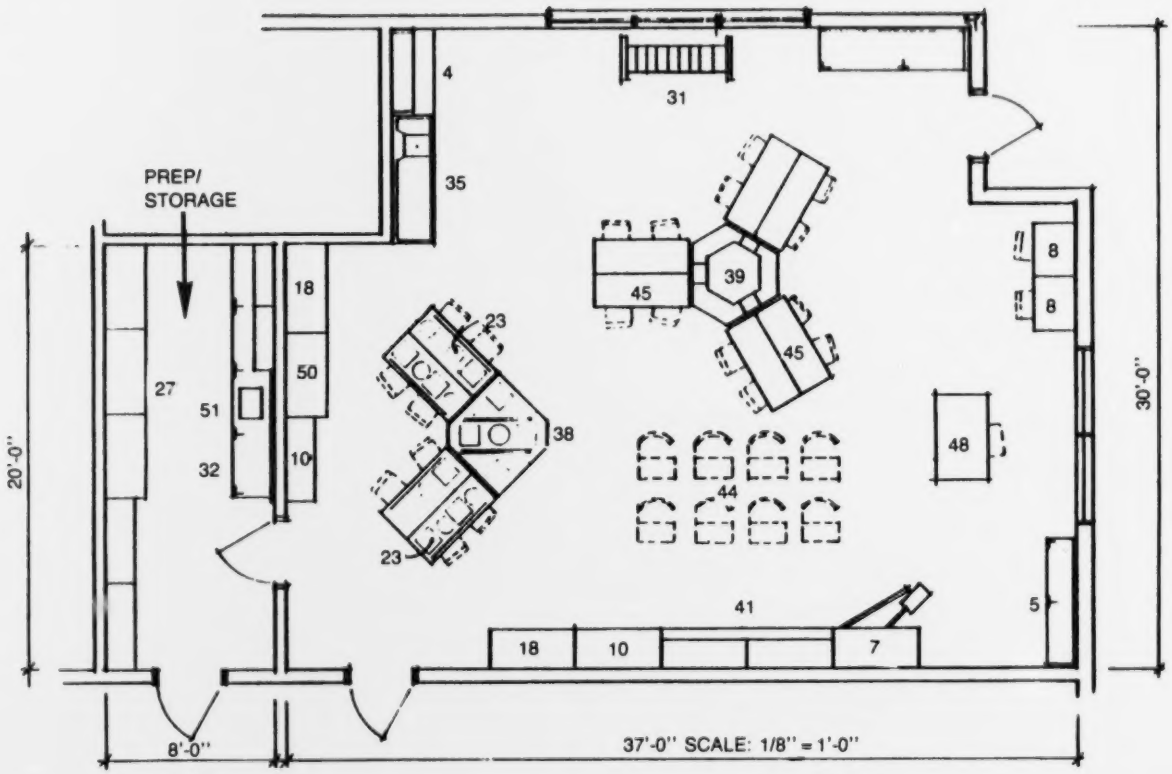
All tables labeled **student table** should be considered as moveable and can be arranged for various types of experimentation.

All floor plans are designed with the following criteria in mind:

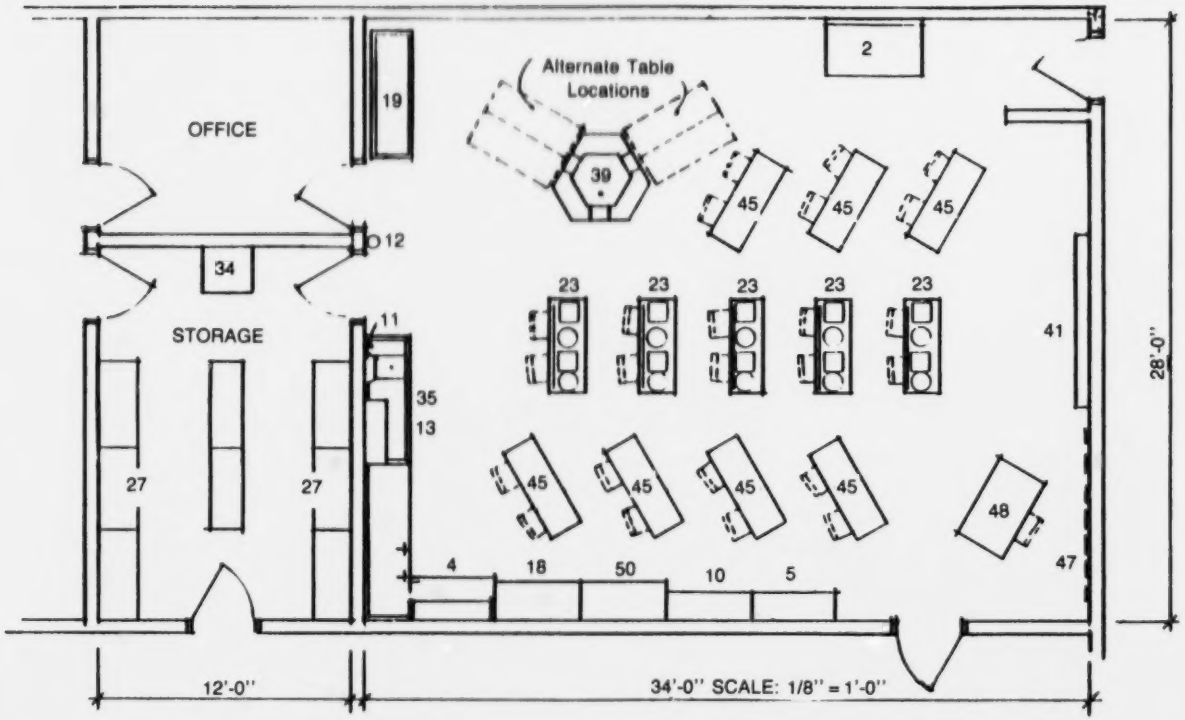
- laboratory safety
- student supervision
- student sight lines
- proper utilization of floor space
- instructor preparation time
- mechanical costs (plumbing and electrical)

The following equipment list is to be used for identification of all items located on the floor plans.

1. acid storage
2. animal study center
3. apron storage
4. aquaria center
5. book shelving
6. chalkboard
7. chalkscreen projection center
8. computer station
9. demonstration table
10. display
11. eye wash
12. fire extinguisher
13. first-aid cabinet
14. flammable storage
15. flatstock storage
16. four-student lab station
17. fume hood
18. general storage
19. germination bed
20. glass tubing storage
21. handicap station
22. high density storage shelving
23. imprinted top project table
24. laboratory cart
25. lecture seating
26. microscope storage
27. open storage
28. overhead mirror
29. pegboard
30. plant study center
31. porta plant study center
32. preparation counter
33. reagent shelving
34. explosion-proof refrigerator
35. rinseaway counter
36. safety goggles storage
37. safety shower/eyewash
38. science discovery center
39. service island
40. skeleton storage
41. sliding chalkboard
42. specimen storage
43. stream table
44. student desk
45. student table (adjustable)
46. student table
47. tackboard
48. teacher's desk
49. torso storage
50. tote tray storage
51. wash-up sink

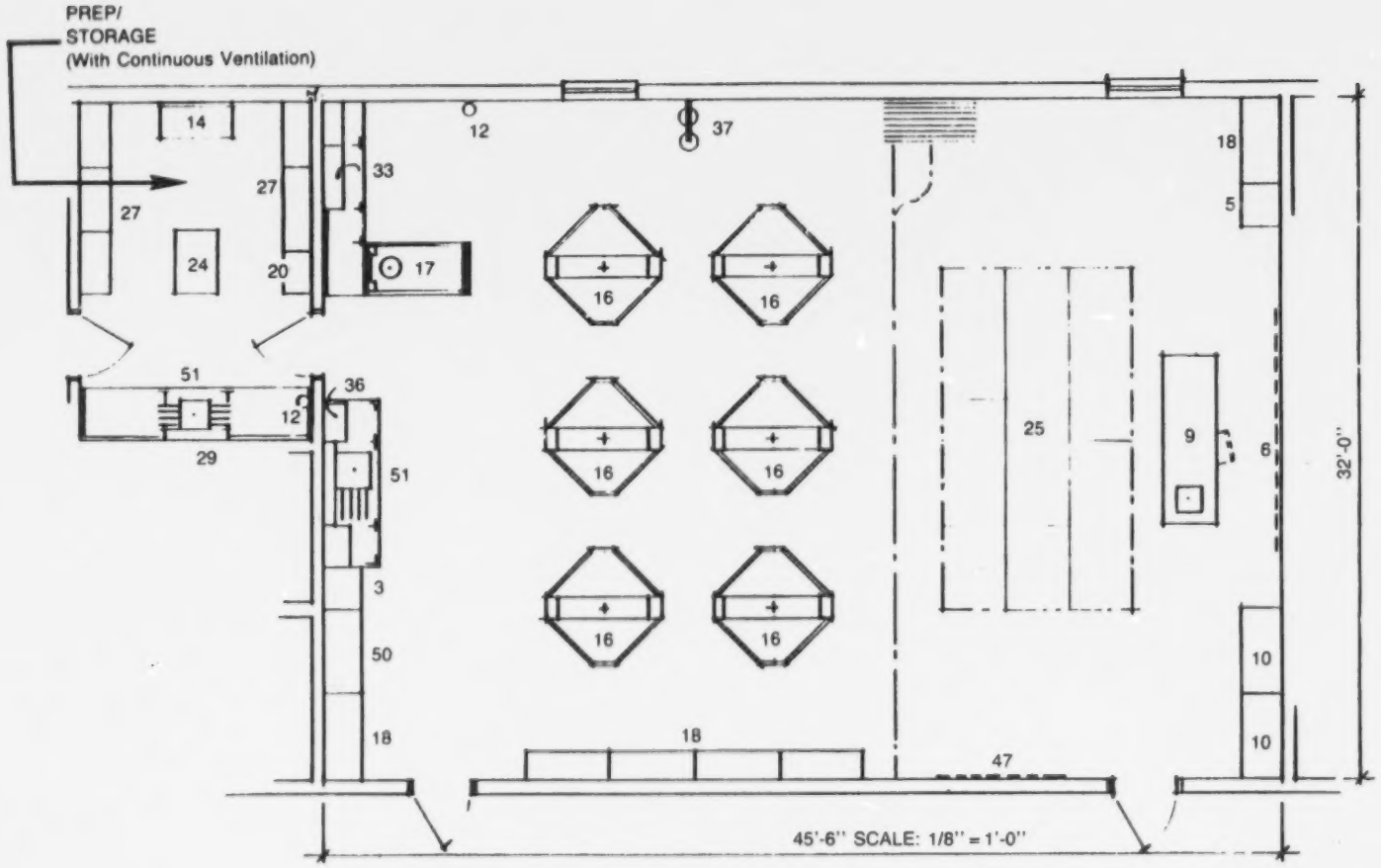


Plan 1
Adaptable for K-6 science. Floor plan utilizes specialty items that facilitate the study of the direct relationship of mathematical calculations to science discovery. Also, the service island with the student table can be used for small-group experiments or a lecture setting.



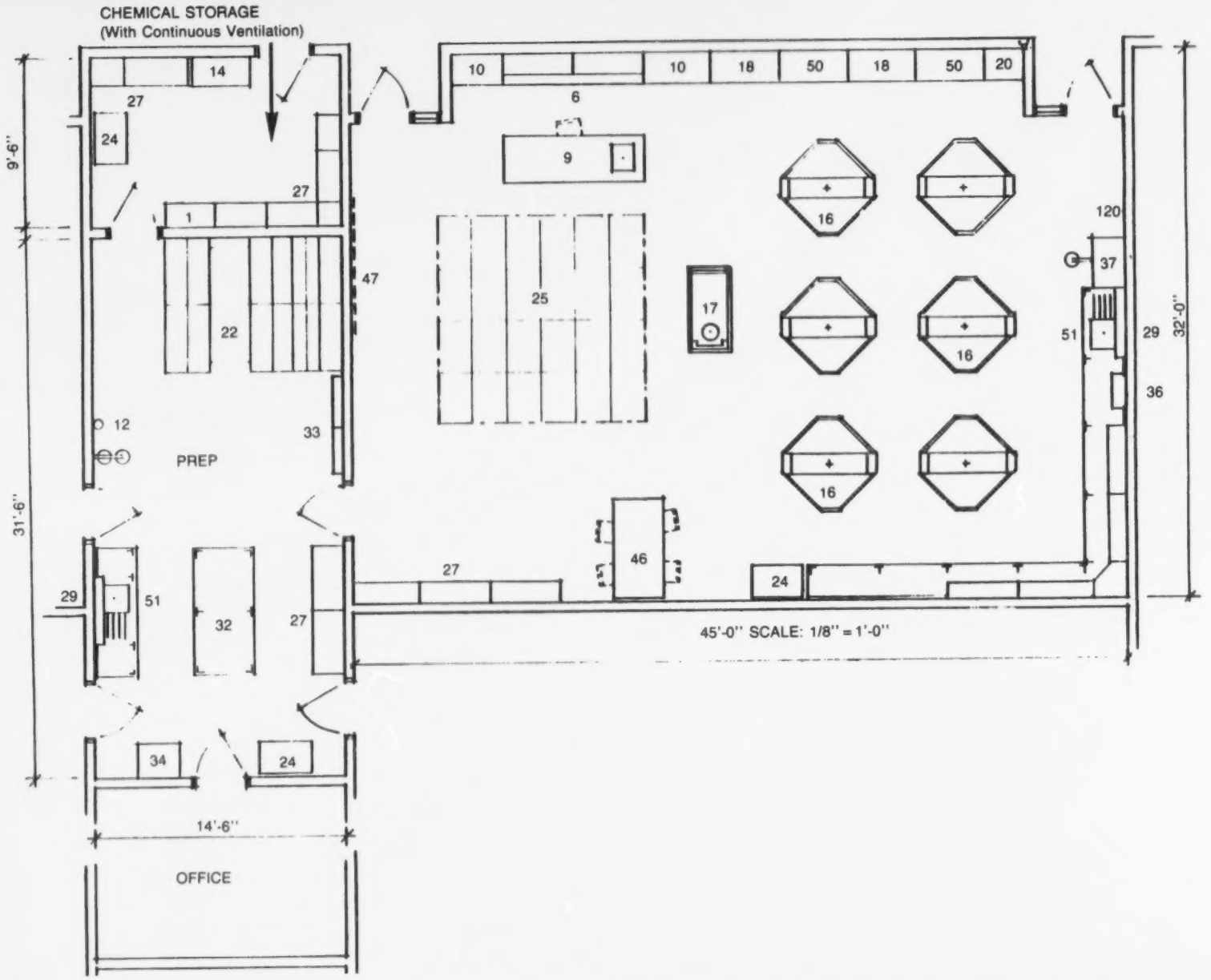
Plan 2

Adaptable for K-6 science. Floor plan utilizes approximately the same space as a conventional classroom. In this room, which includes basic specialty items, students can begin the initial study of earth, life, or physical science.



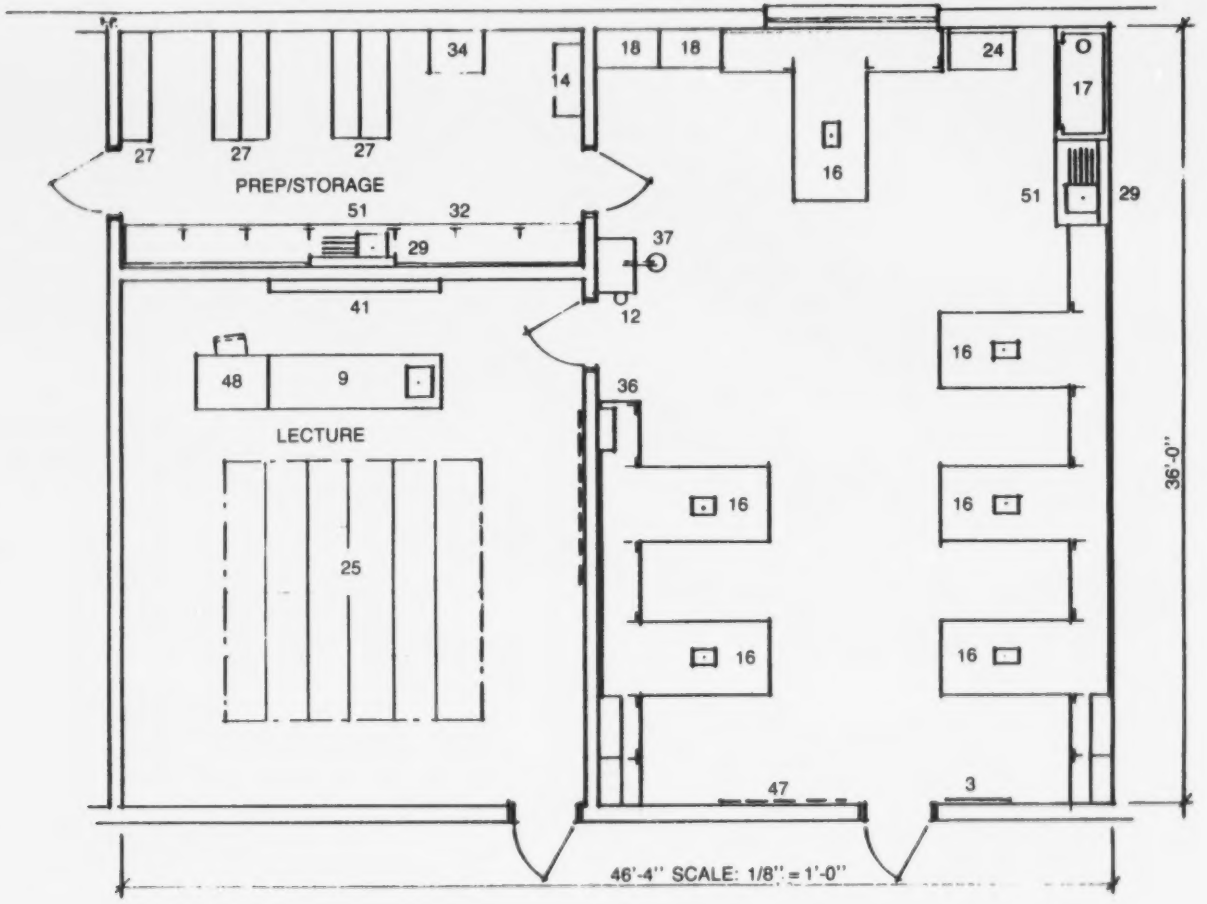
Plan 3

Adaptable for multiscience, chemistry, physical science, and biology. Folding partition separates the lecture area from the laboratory. The location of the fume hood, with a full complement of services, lends itself well to use for demonstration or class overload.

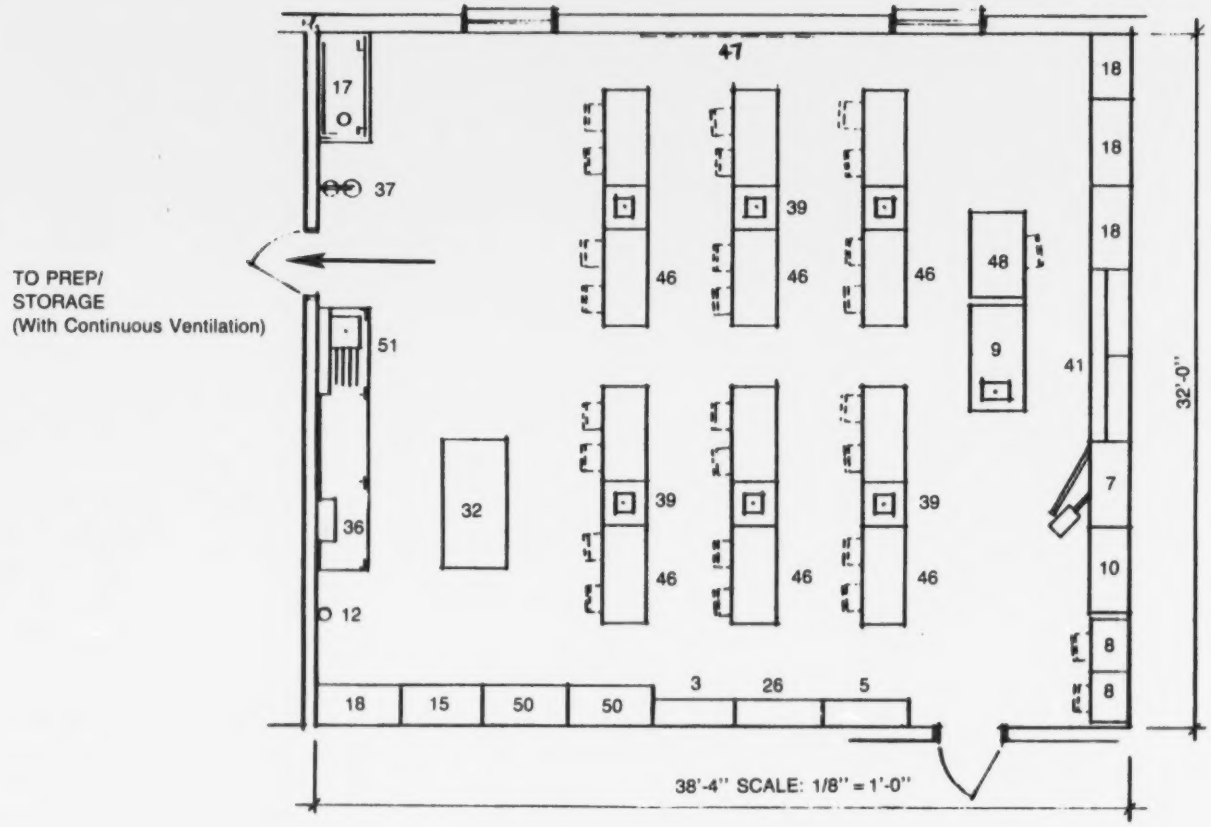


Plan 4

Adaptable for multiscience, chemistry, and biology. Floor plan utilizes large four-student lab stations with required utilities. The central fume hood can be used for demonstration, student projects, or student overload purposes. The large walk-through central storage room has access from four laboratories, the chemical storage room, and the department office.

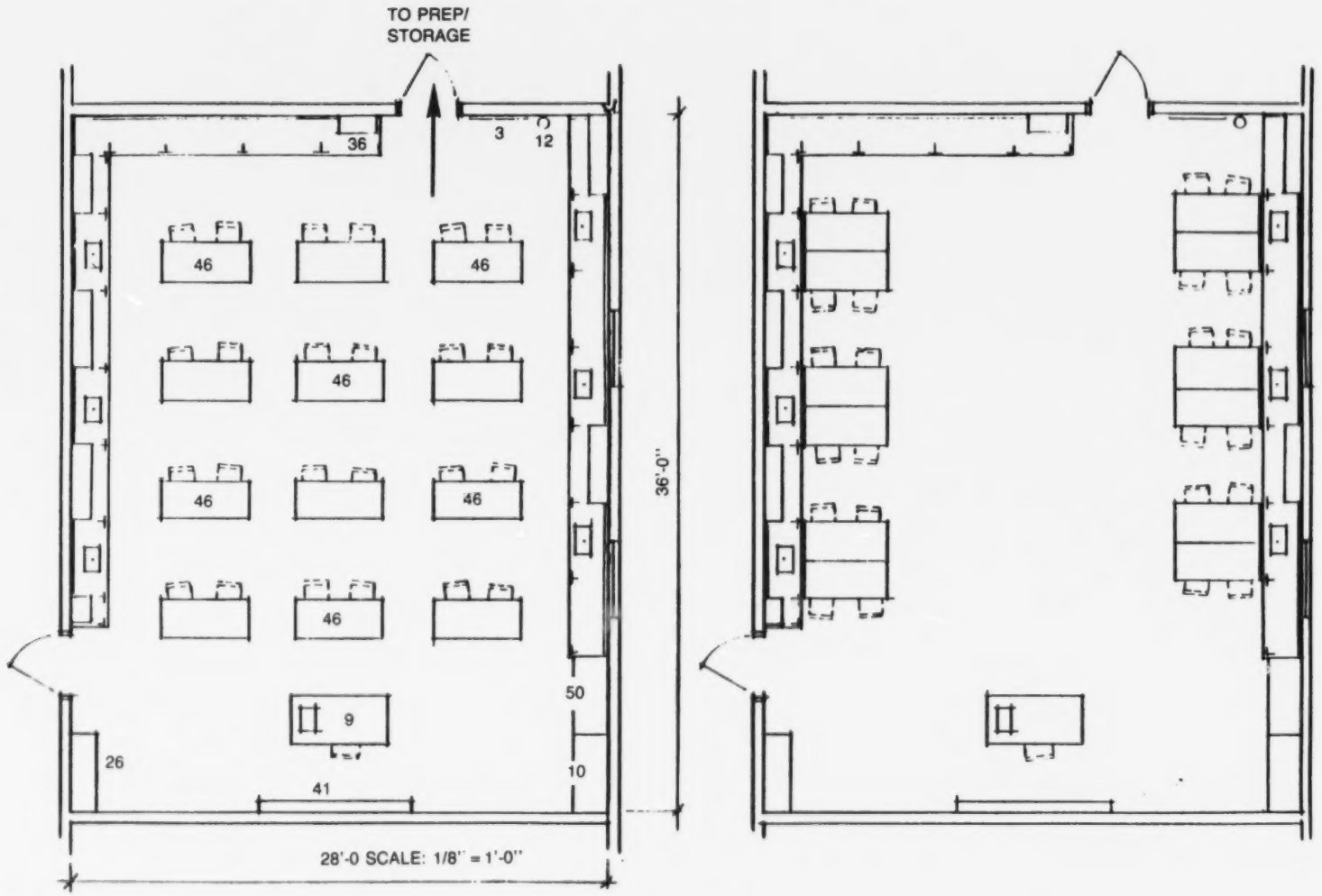


Plan 5
Adaptable for multiscience, chemistry, physics, physical science, or biology. Floor plan utilizes a lecture arrangement separate from the laboratory. With this plan, a teacher could conduct a laboratory class simultaneously with a class lecture being given in the adjoining room.



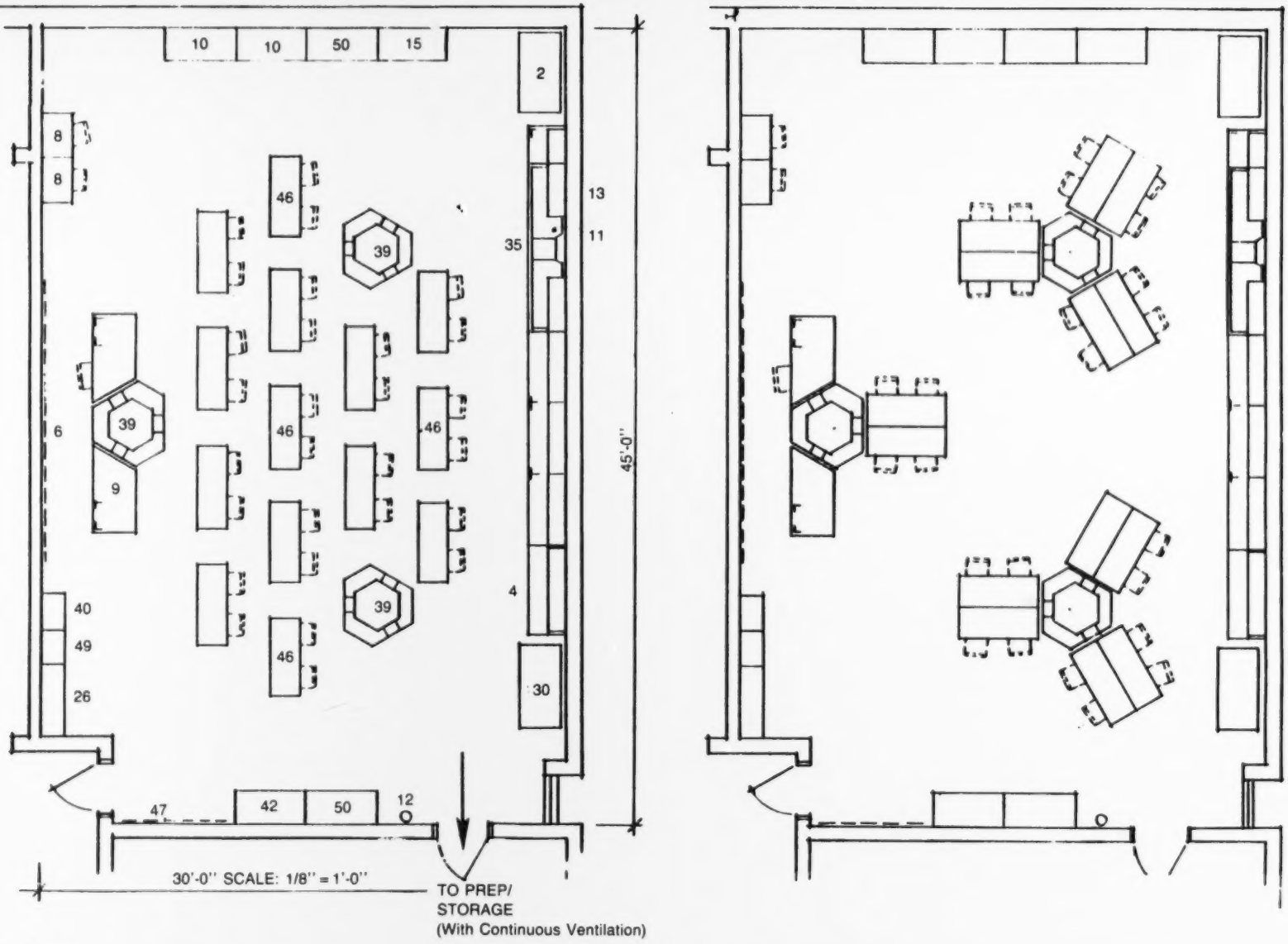
Plan 6

Adaptable for physics, physical science, and biology. This floor plan utilizes moveable student tables for a lecture setting, as well as a laboratory position. The service island features cold water and electric and gas utilities.

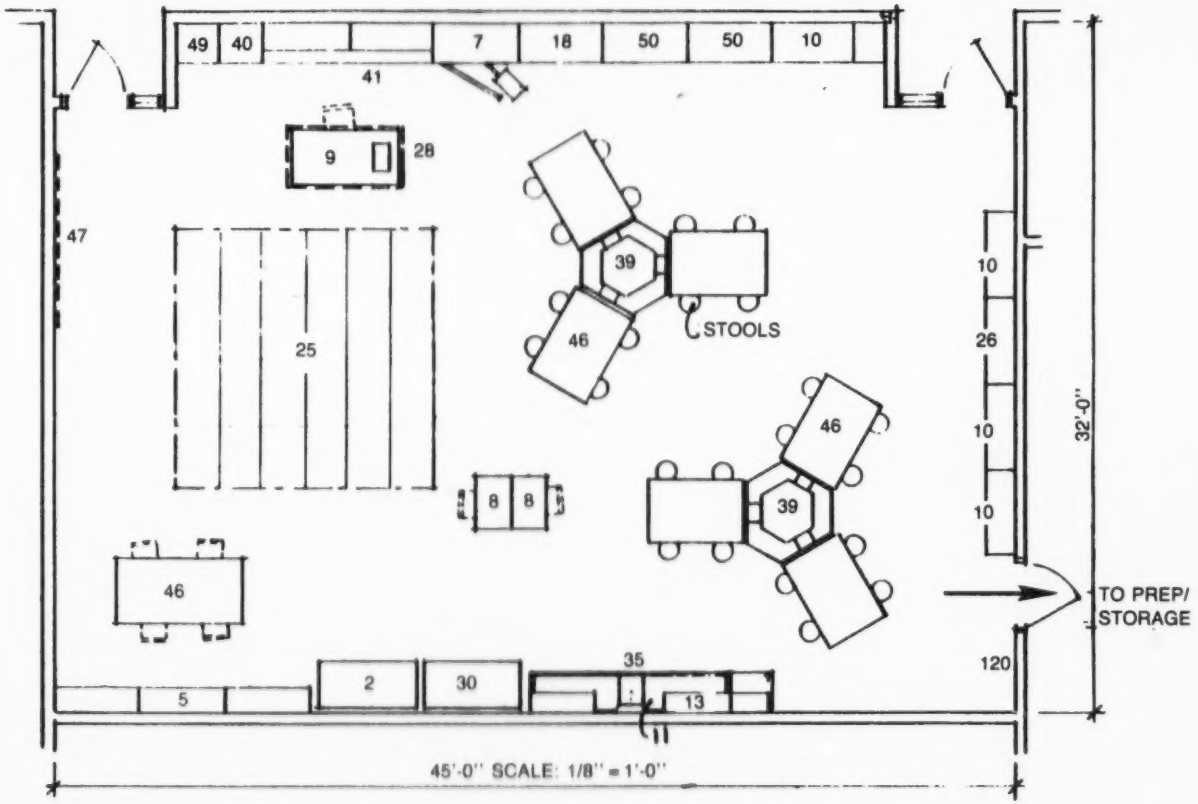


Plan 7

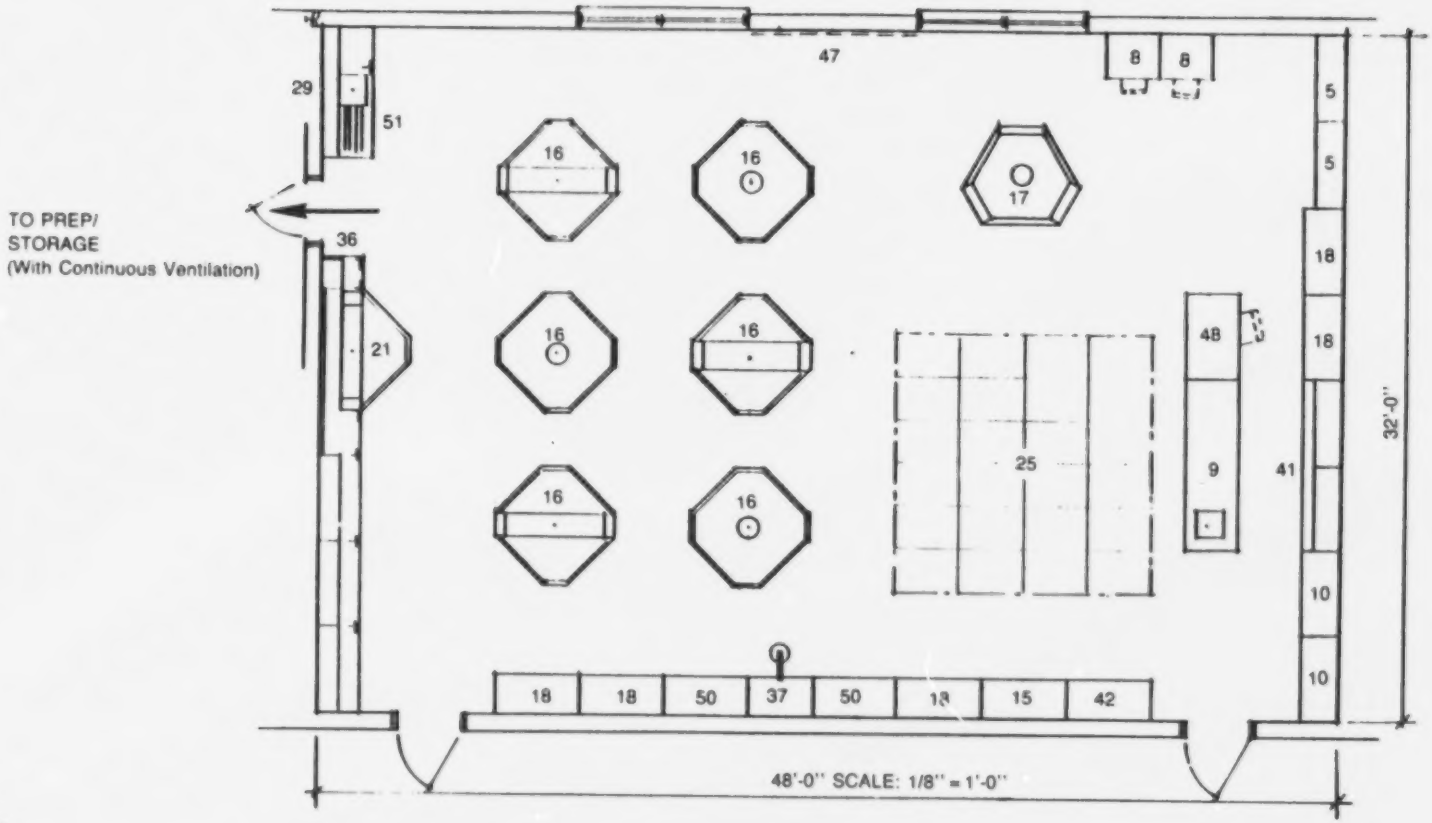
Adaptable for earth science, life science, and biology. Floor plans show a perimeter installation with stand-up work counters with moveable two-student tables of sit-down height. The plan on the left shows all student tables in the lecture/lab arrangement; the right plan shows a laboratory arrangement.



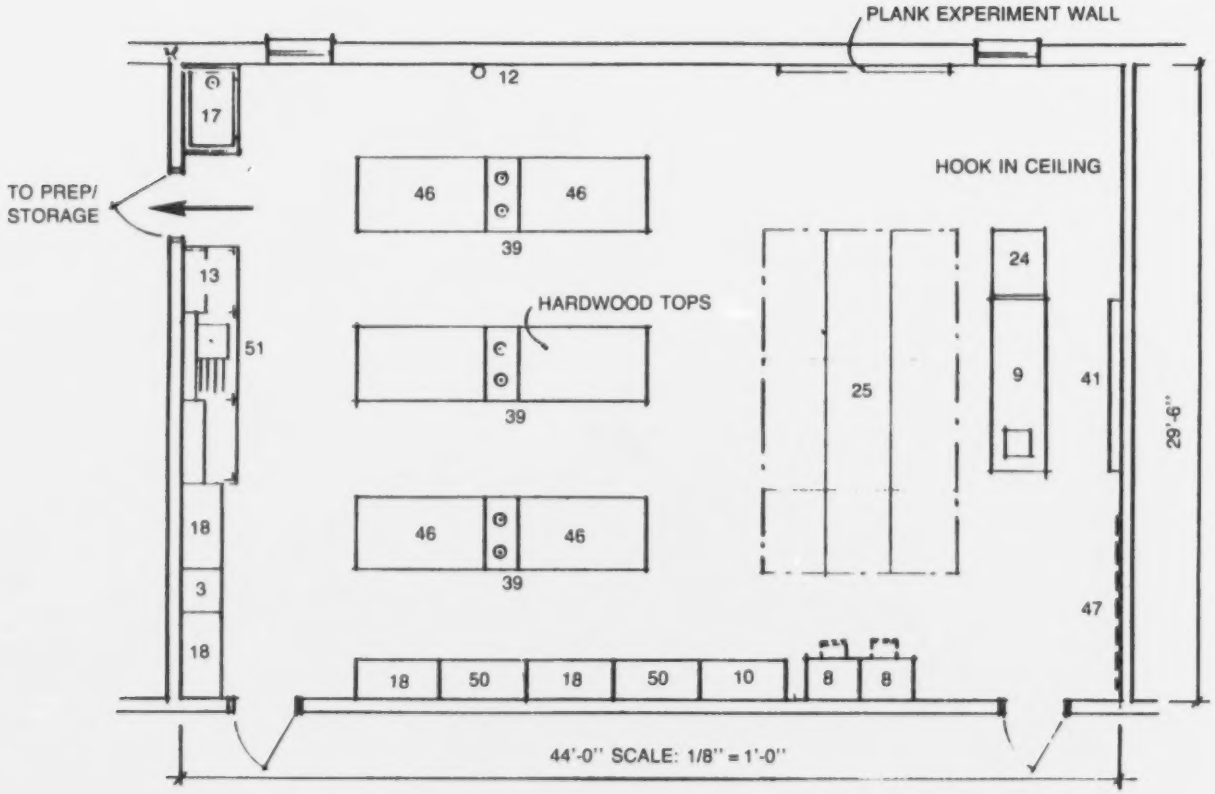
Plan 8
Adaptable for earth science, life science, and biology. Plan on the left shows all student tables in the lecture lab arrangement; the right plan shows a laboratory arrangement. Plenty of storage and specialized furnishings can easily adapt this room to the science curricula.



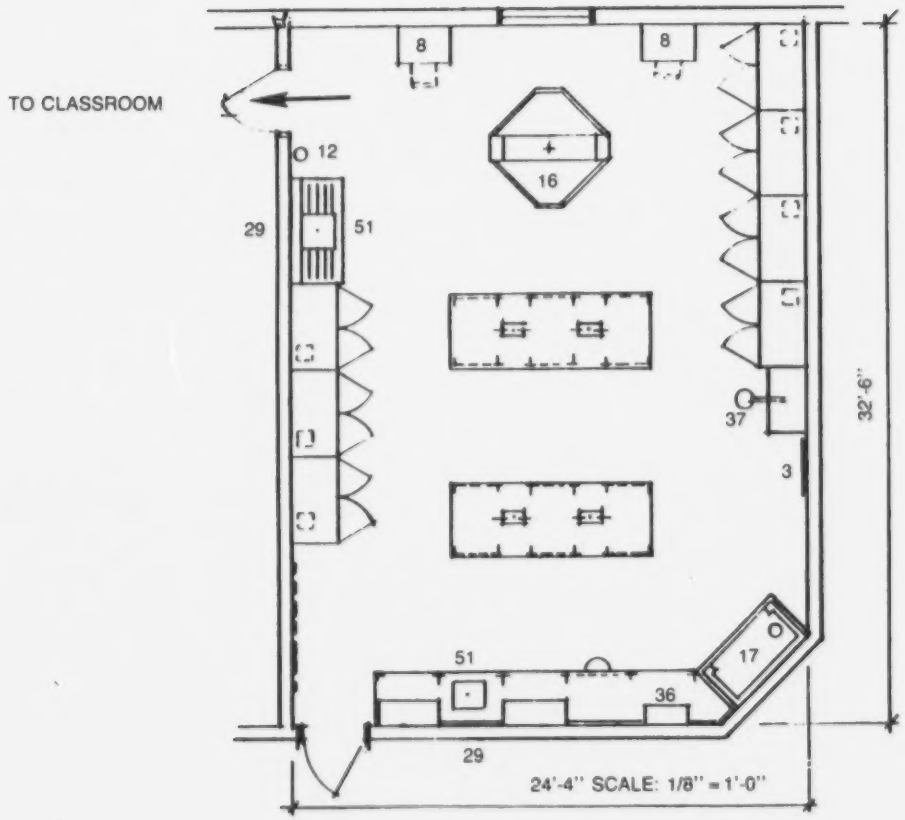
Plan 9
Adaptable for earth science, life science, and biology. Floor plan utilizes an area for lecture separate from the student laboratory. Large service islands with utilities and large moveable student tables allow flexibility within the laboratory.



Plan 10
Adaptable for chemistry, physical science, and biology. Floor plan features extra wide aisles and a handicap position in relation to the laboratory area. The demonstration fume hood has three closed sides and three accessible sides with drop-down safety panels. This unit should also have handicap access.



Plan 11
Physics laboratory. The service islands have two complete sets of utilities with large moveable student tables with edgegrain hardwood tops. A large wash-up sink and small fume hood is shown in the back of the room.



Plan 12
Independent study/research laboratory. Floor plan utilizes a variety of equipment for various disciplines. On each side wall are lockable, individual research, wet carrels with sinks, cold water, gas, electricity, upright rods, and independent lighting. Also, minimal storage and a kneespace for sitting are provided. The center tables also offer a full complement of utilities and sitting space for team research.

Appendices

Appendix A
Conditions of Instruction

The following is reprinted with permission of the National Science Teachers Association.

Conditions of instruction refer to the circumstances in which each teacher works. The most important condition is probably the educational atmosphere. If there is trust and respect among students, teachers, and administrators; and if there is a team spirit that gives education of the individual student priority among school activities; it is likely that good conditions for learning and teaching will prevail.

The recommendations that follow deal with some of the specifiable aspects of conditions for instruction. They are based on the assumptions that a) a science teacher's total assignment must reflect the complexities of the job, b) there must be ample time for both instruction and preparation, and c) there should be provision for ample back-up support. (As appropriate, the recommendations are coded ES, elementary school; MS, middle school; and HS, high school.)

Teaching Assignments

To the science teacher there is nothing so discouraging and counter-productive as being so overloaded with school-assigned tasks that none of the tasks is done with a proficiency that reflects the teacher's abilities, skills, and special knowledge. This is a problem in all teaching, but it is a critical problem in science teaching in which large amounts of equipment and material need to be managed. A related problem is the assignment of school tasks for which the teacher is not trained. The following recommendations are guides to minimize these problems.

ES

Science instruction at the elementary level should be provided by teachers who are competent to teach science.

This recommendation is made to encourage the teaching of science at the elementary level, not to serve as an excuse to omit it. Ideally, science instruction at the elementary level should be the responsibility of a teacher or a group of teachers whose primary function is to teach science. Whether science is taught by a science teacher, the elementary science teacher must possess the science content knowledge, competence in methods, and personal interest to do an effective job.

MS, HS

A science teacher should fulfill all applicable certification requirements for each science course taught.

This recommendation should not preclude involvement in developing or teaching interdisciplinary courses, interdepartmental seminars, the use of team teaching, or other as yet unforeseen innovations in instruction.

ES

Specialized teachers of science in elementary schools should not meet more than three different grade levels or more than five separate classes each day.

Both specialized and self-contained teachers of science in elementary schools will be more effective if they can use adult aides and/or laboratory assistants selected from upper level students or preservice teachers. This type of experience would be especially appropriate as an early field experience for prospective teachers.

MS, HS

A science teacher should have no more than three different course preparations.

Because of differences in the organization of science instruction, it may not be clear as to what constitutes a "course preparation." In a sense, every single class taught by a teacher constitutes a separate preparation. If a course is taught with individualized instruction, the teacher's preparation work increases by a factor of the number of students taught.

Whether a teacher primarily uses team teaching or individualized instruction, there needs to be some reasonable limitation to his or her separate preparation situations.

School administrators need to recognize the extra time required by science teachers to manage laboratories.

ES

Teachers who have the added responsibility of being lead science teacher or specialized science teacher should have fewer nonteaching assignments.

The extra demands of managing equipment and materials should be compensated by a reduction of nonteaching duties such as playground or lunch room assignments.

MS, HS

If science teachers are given responsible assignments beyond their usual classroom assignments, their total load should be adjusted to a reasonable level.

A teacher given an assignment such as department chairman, master teacher, supervisor of apprentice teachers, or chairman of a curriculum study group cannot be expected to carry it out effectively and still do full justice to the primary responsibility of teaching unless some adjustment is made. The adjustment should be in proportion to the magnitude and intensity of the added assignment.

ES, MS, HS

Every science teacher's day should be arranged so that he or she has the equivalent of one period to meet with students on an individual basis, and/or to use as preparation time.

Because of differences in the organization of school day schedules, a period might be arbitrarily defined as containing 45 minutes. Students should know that consultation time with the science teacher exists and they should be free, within the rules of conduct of the school, to take advantage of it.

ES, MS, HS

Science class sections should be strictly limited to 24 students per instructor or the capacity of the room, whichever is less.

Hands-on activities and laboratory experiments are an integral part of modern science instruction. Effective use of hands-on and laboratory based instruction requires individual participation by students and close student-teacher interaction. A 24-student restriction is necessary to maintain education quality. A teacher cannot supervise more than 24 students, even in the restricted sense of keeping order. The risk to student safety, and to expensive equipment, escalates rapidly as the number of students in the laboratory at one time increases.

ES

A specialized science teacher's involvement in extracurricular activities should emphasize the relevance of science to the whole school community.

A teacher of science provides the only real role model of "scientist" for most students. It is important to project an image that reflects the "normalcy" of scientists.

MS, HS

A science teacher's involvement in extracurricular activities should be limited to those with minimal stress and time requirements.

All teachers should share in the responsibility for carrying out the whole school program. Some extracurricular activities such as science clubs or science fairs can even be regarded as an extension of the formal job of science teaching.

Some extracurricular assignments, such as interscholastic sports coaching, have heavy time demands and generate stress levels beyond any dollar compensation. These may seriously detract from a teacher's ability to fulfill major teaching responsibilities.

On the other hand, some participation in extracurricular activities is necessary to keep the science teacher and science in tune with the total school community.

Working Space

Although space for instructional activities must be given priority, these facilities are not sufficient space for teachers. The nature of science and science teaching dictates that there should be places available where the science teacher can prepare for instructional activities.

Ample space is needed for the storage of supplies and equipment.

ES

This space should be separate from and equivalent to at least 10 percent of the laboratory/classroom space it serves. It may be combined with storage space for materials for other subjects. Storage facilities should conform to accepted safety standards for the storage of materials and be under continuous adult supervision. Special arrangements must be provided for humane year-round care of animals.

MS

This space should be separate from and equivalent to at least 15 percent of the laboratory space it services. Such space may be separate for each laboratory/classroom or be a common facility. Storage facilities should conform to accepted safety standards for the storage of materials and be under continuous adult supervision. Special arrangements must be provided for humane year-round care of animals.

HS

This space should be separate from and equivalent to at least 15 percent of the laboratory space it services. Such space may be separate for each laboratory/classroom or be a common facility. Storage facilities should conform to accepted safety standards for the storage of materials and be under continuous adult supervision. If animals are kept permanently at the school, then a special animal room must be provided and arrangements made for year-round humane care of the animals.

Every science teacher should have access to a preparation area that is secure from student intervention.

ES

This area need not be large or elaborate but should provide a place for teachers to set up and try demonstrations, arrange equipment, gather materials, etc. prior to their classroom use.

MS,HS

Teachers should have a place where they can prepare materials for student experimental work, set up and test demonstrations, and sometimes conduct experiments on their own. Depending upon the design of the separate science department, these teacher preparation areas should be separate from extended storage space. The preparation areas must be provided with convenient electric, water, and gas outlets; waste disposal facilities; and safety devices.

ES, MS, HS

Every science teacher should have office space.

Teachers need a place where they can meet their students individually, where they can do their paperwork without interruption, where they can keep files of confidential materials, and where they can organize a variety of teaching materials. If a teacher is the only one to use a classroom all day, it may be possible to use part of it as an office. Otherwise, private or semi-private office space should be provided. Ideally, this space should have a telephone or easy access to one. A semi-private office has the advantage of increasing professional interaction among science teaching colleagues.

ES, MS, HS

The science teacher needs access to a professional library.

Science teachers, faced with the task of staying up-to-date in science, science applications, science teaching, and the relationships of science to society, carry a considerable academic burden. Consequently, teachers frequently need to study appropriate books and journals and cannot function effectively for long without these resources. Teachers should have immediate access to a professional library that contains appropriate material. This library should exist as a separate facility within the school or could be a part of a group office.

The opportunity to further one's knowledge base by having a readily accessible professional library is one of the personal rewards of teaching science.

Services

A science teacher needs assistance to do the job of teaching well. A talented instructor is not always a talented clerical worker or equipment cleaner and repairer, and certainly instruction has priority.

It is not only with chores that a science teacher needs help, however. Teachers can do a better job of teaching if they have frequent contact with new ideas and methods which extend their experience and knowledge.

ES

Schools should appoint one teacher as lead science teacher or science chairperson.

The main function of this chairperson is the improvement of science teaching and learning. This person provides leadership in staff development, curriculum development, materials, management, and coordination of teachers' efforts toward achieving school goals. The chairperson should have an excellent professional background, high standards, and be a dedicated teacher.

MS, HS

Schools employing three or more science teachers should have a science department headed by a chairperson.

The main function of the chairperson is the improvement of science teaching and learning. This person provides leadership in staff development, curriculum development, materials management, and coordination of teachers' efforts toward achieving school goals. The chairperson should have an excellent professional background, high standards, and be a dedicated teacher. This person's teaching load should be adjusted to give him or her at least one hour each school day for fulfilling departmental responsibilities.

ES

Professional laboratory assistants should be available.

The chief tasks of these assistants would be maintenance of materials, supplies, equipment kits, aquariums, etc., and assistance on field trips and other nonclassroom learning activities. In some situations, qualified volunteers may do the job. In larger schools or systems a full-time paid professional may serve several schools.

Teachers in training from local colleges could gain early field experience by serving in this position.

MS,HS

The chief tasks of these paid adult assistants, or qualified and/or advanced student assistants, would be to assist the teacher with such things as setting up demonstrations and student laboratory experiments, and ordering, assembling, maintaining, and keeping an inventory of supplies and equipment. Advanced students could receive special course credit in lieu of pay.

Teachers in training from local colleges could gain early field experience by serving in this position.

ES, MS, HS

Regular professional secretarial and clerical help should be available to science teachers.

This help should be available at least two hours per week at a time convenient to the teacher.

This help should be available at least one hour a day to each teacher at a time convenient to the teacher. Student help is ordinarily an unsatisfactory substitute for this.

ES

Consultants and specialists should be called in to help teachers of science as needed.

These may be specialists on new science programs, specialists in using new learning technology, science educators to help individual teachers with classroom problems, safety engineers, and the like. Contact with one or more of these outside persons should occur at least once each school year.

An organized science volunteer group may be able to provide talks, tours, etc. to update teacher knowledge and even help in locating used but useful materials and equipment locally.

MS,HS

Consultants and specialists should be called in to help the science department and science teachers as needed.

These may be specialists in new science programs, specialists in using new learning technology, science educators to help individual teachers with classroom problems, safety engineers, and the like.

Proper use of consultants will result in a dynamic group of teachers that continue to develop their knowledge, skills, and interests.

ES, MS, HS

Each school system should have a voluntary Science Advisory Group drawn from the community. Its focus should cover K-Grade 12.

This group will provide a two-way communication line between community and teachers to share needs and concerns. This group would be strictly advisory and would not have policy making power. Its composition should vary gradually from year to year.

Each science teacher must be supported by an adequate budget. Because of local differences, it is not practical to specify exact budget amounts in this document. It is imperative, however, that the budget include both operating and equipment acquisition costs and that science teachers are directly involved in establishing the budget. The following recommendations provide some guidelines for the development of an adequate budget.

ES, MS, HS

The science budget should appear as a separate account within the whole school budget, and it should be subdivided according to function.

Separate line items should indicate the amounts budgeted for the purchase of laboratory equipment, for the repair and maintenance of equipment, and for supplies. This will eliminate unnecessary confusion over the true size of the science budget, or over the relative distribution within the department of capital expenses and annual operating expenses. Such information is necessary if science teachers are to plan their work efficiently.

ES, MS, HS

Supplies (expendables) should be budgeted on a per learner basis with the amount varying according to the nature of the course, the grade level of instruction, and the expendables involved.

It must be kept in mind that there is a basic budget below which any science class or course cannot operate, no matter how few students are enrolled.

Budget provisions need to be made so that certain items may be purchased as needed during the school year. These items will often be locally obtainable. They include perishable materials and items for which need develops as a result of unforeseen class interest and development.

ES

A substantial petty cash fund should be established to meet this need. It should be accessible to all teachers involved in science with approval by the science chairperson or lead science teacher.

MS, HS

A substantial petty cash fund should be established to meet this need. It should be accessible to every teacher in the science department with approval by the chairperson. This fund could be supplemented by laboratory fees if these are permitted.

ES

Simple but useful laboratory materials should be obtained from local business and industry surplus to supplement regular budgetary sources. Such material might include obsolete wire, glassware, and storage boxes.

Local service and educational organizations can be enlisted in the search for usable material. In a real sense, the community thus supports schools with resources other than actual dollars.

MS, HS

Major equipment acquisitions should be planned on a three- to five-year basis with priorities set by a consensus of the science teachers.

It is recognized that budget restrictions may prevent needed funds from coming from the school budget. Teachers and administrators should take the initiative in identifying and applying for foundation grants. This will be especially effective if done on a dollar matching basis. Local service organizations, businesses, and industries may also be able to provide resources if a need is clearly documented.

Appendix B
Selected Safety Directives

The following are excerpts from state laws and regulations that apply to safety in science education:

- *Texas School Law Bulletin*, Texas Education Agency Publication AD6 130 01, Section 21.909, page 190:

Sec. 21.909. Protective Eye Devices in Public Schools

(a) industrial quality eye-protective devices shall be worn by every teacher and pupil in Texas participating in any of the following courses:

(1) vocational or industrial arts shops or laboratories involving experience with:

(A) hot molten materials;
(B) milling, sawing, turning, shaping, cutting, or stamping of any solid materials;
(C) heat treatment tempering, or kiln firing of any metal or other materials;
(D) gas or electric arc welding; or
(E) caustic or explosive materials; or

(2) chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids.

(b) In this section, "industrial quality eye-protective devices" means devices meeting the standards set by the State Department of Health.

(c) The governing boards and administrators of Texas school districts offering any of the listed courses are responsible for furnishing free of charge or providing at cost to teachers and pupils participating in the courses the required eye-protective devices.

(d) Whenever an accident occurs during the conduct of any of the courses described in Subsection (a) of this section, and an injury to the eye of a teacher or pupil results, the principal shall make a full written report of the accident and injury to the State Department of Education. The department shall prescribe the form and content of the reports and shall maintain a file of all reports submitted.

- *Standards for Eye Protection in Public Schools*, Texas State Department of Health, Health Regulation No. 5, Section 5.5, pages 6-7.

5.5.1 Description. Goggles shall consist of a frame (composed of a flexible, chemical-resistant, nontoxic, nonirritating, and slow-burning material, forming a lens holder), lenses, and a positive means of support on the face such as an adjustable headband of suitable material to retain the frame comfortably snugly in place in front of eyes. The lens holder shall be such that the lenses are held firmly and tightly and may be removed or replaced without the use of tools. The goggles may be ventilated or not, as required by their intended use. Where chemical goggles are ventilated, the openings shall be such as to render the goggles splashproof.

5.5.2 Protection. Goggles shall provide eye protection from fine dusts, fumes, liquids, splashes, mists, and spray.

5.5.3 Application. Specific application for use of flexible fitting goggles will be found in Table 1 below.

5.5.4 Materials and Methods of Test. Plastic lenses used in flexible fitting goggles shall be not less than 0.050 inch in thickness.

Materials used shall be capable of withstanding the disinfection, corrosion resistance, water absorption, and flammability tests outlined in Section 6.

- *Standards for Eye Protection in Public Schools*, Texas State Department of Health, Health Regulation No. 5, Section 6.2, page 9.

6.2 Disinfection. All materials shall be such as to withstand, without visible deterioration or discoloration, washing in detergents and warm water, rinsing to remove all traces of detergent, and disinfection by the following methods:

*(1) Immersion for 10 minutes in solution of formalin made by placing one part of 40 percent formaldehyde solution in nine parts of water at a room temperature of 68° F.

*(2) Subjection to a moist atmosphere of formaldehyde for a period of 10 minutes at a room temperature of 68° F.

(3) Immersion for 10 minutes in a solution of modified phenolics, hypochlorite, or quaternary ammonium compounds in strength specified by the manufacturer at a room temperature of 68° F.

- *Standards for Eye Protection in Public Schools*, Texas State Department of Health, Health Regulation No. 5, Table 1, page 12.

Table 1
Selection of Eye- and Face-Protective Devices

Hazard Involved	Part to be Protected	Permissible Protective Devices Type
Dust and small flying particles	Eyes, face	Goggles Spectacles Face shields
Gases, fumes, and smoke	Eyes, face	Goggles
Liquids	Eyes, face	Goggles Face shields

- Texas Hazard Communication Act of 1985, Texas Civil Statutes, Article 5182b

The following is a list of district responsibilities to its employees as specified in the Act. A school district is required to:

- Post a notice of the Act and its provisions to employees. (See page 56.) For school districts, the term *employees* includes faculty, staff, and students.

*Research findings show that formaldehyde is a suspected carcinogen. The use of formaldehyde in school science laboratories is not recommended and strongly discouraged.

- Obtain Material Safety Data Sheets (MSDSs) for each hazardous chemical from the manufacturer. Districts should request MSDSs from the manufacturer for all hazardous chemicals purchased, even those purchased prior to January 1, 1986. The MSDSs must be readily available for reference by employees.

- Provide training for faculty, staff, and students who handle hazardous chemicals. At a minimum, this training includes interpreting chemical labels and MSDSs and providing information about the location of hazardous chemicals, their acute and chronic effects, safe handling of hazardous chemicals used by employees, use of protective equipment, and first-aid procedures.

- Notify the Occupational Health Program, Texas Department of Health in writing that training has been completed for all faculty, staff, and students handling hazardous chemicals. This notification is required annually.

- Ensure that containers of hazardous chemicals are labeled appropriately with the identity of the chemical, the physical and health hazards, and the name and address of the manufacturer.

- Provide to the chief of the fire department having jurisdiction over the areas of the district where hazardous chemicals are used or stored a written list of names and telephone numbers of persons knowledgeable about the chemicals who can be contacted in case of an emergency.

In addition to these requirements, the local fire department may request an inventory of chemicals, their MSDSs, and permission to inspect the chemicals listed on the inventory. If these items are requested, the school district must supply them.

School districts must communicate information related to the Texas Hazard Communication Act to faculty and staff at the earliest convenience. Science and vocational teachers especially will need to incorporate the required hazard communication training into their safety instructions prior to students working with hazardous chemicals.

NOTICE TO EMPLOYEES

The Texas Hazard Communication Act of 1985 Texas Civil Statutes, Article 5182b Requires Certain Employers to

provide employees, local fire departments, the Texas Department of Health, and other interested persons with specific information on the hazards of chemicals in use. As required by law, your employer must provide you with certain information and training, starting January 1, 1986. A brief summary of the law follows:

1. Employers must develop a list of hazardous chemicals used or stored in the workplace, each in excess of 55 gallons or 500 pounds. Smaller quantities may be reported. This list shall be updated by the employer as necessary, but at least annually. The list must be sent to the Texas Department of Health at least annually, to be made available to the general public on request.

2. Employees who may be exposed to hazardous chemicals shall be informed of the exposure by the employer and shall have ready access to the workplace chemical list and to the most current material safety data sheets, which detail physical and health hazards and other pertinent information. The list must state which chemicals are present in each work area.

3. Employees shall receive training by the employer on the hazards of the chemicals and on measures they can take to protect themselves from those hazards, and shall be provided with appropriate personal protective equipment. This training shall be provided at least annually and must be reported by the nonmanufacturing employer to the Texas Department of Health within 30 days of completion.

4. Employees shall not be required to work with hazardous chemicals from unlabeled containers, except portable containers for immediate use, the contents of which are known to the user.

5. Employers must provide the names and telephone numbers of knowledgeable company representatives to the local fire department, as well as other information if the fire department requests it.

6. The following chemicals are exempted from coverage by this act: articles that do not normally release hazardous chemicals, food, cosmetics, pesticides for use (but not pesticide formulation), hazardous waste, and some other materials. Most of these are covered by other acts. Manufacturers are exempt from some provisions of the State law since they are covered under similar rules adopted by the Federal Occupational Safety and Health Administration (OSHA).

7. Employees may file complaints with the Texas Department of Health, and may not be discharged or discriminated against in any manner for the exercise of any rights provided by this act. Employees and citizens may make written requests to the Texas Department of Health to require listing of small quantities of certain highly hazardous chemicals.

EMPLOYERS MAY BE SUBJECT TO ADMINISTRATIVE PENALTIES AND CIVIL OR CRIMINAL FINES RANGING FROM $500 TO $25,000 FOR VIOLATIONS OF THIS ACT.

Further information may be obtained from:
Occupational Health Program
Texas Department of Health
1100 West 49th Street
Austin, TX 78756
(512) 458-7410

The Texas Hazard Communication Act
Resources to Aid Teachers

The Texas Hazard Communication Act **became effective on January 1, 1986.** It effects schools and science classes. The following resources will help educators improve the safety of classrooms, field experiences, and laboratories and meet the requirements of the Hazard Communication Act:

- American Chemical Society

A scientific, educational, and professional society of chemists and chemical engineers which publishes material on chemical safety.

1155 16th Street NW
Washington, D.C. 20036
(202) 872-4600

- American Conference of Governmental Industrial Hygienists

Members are employed by various governmental units (state and federal) and are responsible for full-time programs of industrial hygiene. This professional society offers many publications on occupational safety and health. Ask for "Threshold Limit Values" book.

6500 Glenway Avenue
Building D7
Cincinnati, OH 45211
(513) 661-7881

- American Industrial Hygiene Association

Members are trained to recognize and control health hazards and to prevent related illness. The Association promotes the study and control of environmental factors affecting the health of industrial workers and provides information and communication services pertaining to industrial hygiene.

475 Wolf Ledges Parkway
Akron, OH 44311
(216) 762-7294

- American Medical Association

A professional association that promotes the art and science of medicine and the betterment of public health, the AMA provides information on a variety of medical and health topics.

535 North Dearborn Street
Chicago, IL 60610
(312) 645-5000

- American National Standards Institute

The Institute is a federation of industrial, trade, technical, labor, and professional organizations; government agencies; and consumer groups. It coordinates the development of standards in multiple subject areas.

1430 Broadway
New York, NY 10018
(212) 354-3300

- American Society for Testing and Materials

Engineers, scientists, and technicians hold membership as individuals or as representatives of business firms, government agencies, educational institutions, or independent laboratories. ASTM establishes voluntary consensus standards for materials, products, systems, and services.

1916 Race Street
Philadelphia, PA 19103
(215) 299-5400

- American Society of Safety Engineers

A professional society of safety engineers, safety directors, and others concerned with accident prevention and safety programs.

1800 East Oakton Street
Des Plaines, IL 60018-2187
(312) 692-4121

- Compressed Gas Association

The CGA submits recommendations to appropriate government agencies concerning improved safety standards and methods of handling, transporting, and storing compressed gases; advises regulatory authorities and other agencies on the safe handling of same; and collaborates with national organizations to develop specifications and improved standards of safety for compressed gases.

1235 Jefferson Davis Highway
Arlington, VA 22202
(703) 979-0900

- Industrial Health Foundation, Inc.

The Foundation offers engineering, occupational medicine toxicological, and information services. The latter includes plant visits and surveys, special studies, and the availability of trained personnel to supplement members' staffs on a consultant basis.

34 Penn Circle West
Pittsburgh, PA 15206
(412) 363-6600

- National Fire Protection Association (NFPA)

NFPA membership is drawn from fire service centers, business and industry, health care, educational and other institutions, insurance companies, government at all levels, architects and engineers, etc. The Association serves as a clearinghouse of information and compiles annual statistics on the causes and occupancies of all fires.

Battery March Park
Quincy, MA 02269
(617) 770-3000

- National Institute for Occupational Safety and Health

NIOSH is the principal federal agency engaged in research, education, and training related to occupational safety and health. It publishes or has available material on safety standards and on all aspects of occupational health.

Technical Information Division
4676 Columbia Parkway
Cincinnati, OH 45226
(513) 533-8328

- National Safety Council

The Council is an independent nonprofit organization whose goal is to reduce the number and severity of all kinds of accidents by collecting and distributing information on ways to prevent them. It has many publications on occupational safety and health.

444 North Michigan Avenue
Chicago, IL 60611
(312) 527-4800

- Occupational Safety and Health Administration (OSHA)

OSHA produces a list of hazardous chemicals. Ask for the "Z" list.

Room 602
555 Griffin Square
Dallas, TX 75202
(214) 767-4731

- Texas Department of Health

This state agency is responsible for the enforcement of the Hazard Communication Act.

Occupational Health Program
Texas Department of Health
1100 West 49th Street
Austin, TX 78756
(512) 458-7410

- **Texas Water Commission**

This agency supplies a list of authorized commercial industrial solid wastes sites and issues solid wastes permits and disposal well permits.

P.O. Box 13087
Capitol Station
Austin, TX 78711
(512) 463-7948

- **Toxline**

The National Library of Medicine maintains an extensive collection of computerized toxicology information. Its Toxline (Toxicology Information Online) contains more than 380,000 references to published human and animal toxicity studies and covers the effects of chemicals and pollutants on the environment, adverse drug reactions, and analytical methodology.

Toxicology Information Program
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894
(301) 496-1131

- **Underwriters Laboratories, Inc.**

An independent not-for-profit organization, Underwriters Laboratories examines and tests devices, systems, and materials. Services include listing, classification, recognition, certification, and inspection.

333 Pfingsten Road
Northbrook, IL 60062
(312) 272-8800

Appendix C
Laboratory Safety Checklist

Science teachers should check all physical facilities annually using the following checklist. They should file a copy of the checklist with the building principal and take prompt action to correct any unsafe conditions and practices so that maximum safety is ensured at all times.

Teachers should notify in writing the principal and department chairperson of the existence of any hazard.

Section I: Laboratory Classroom

Safety Factor	Yes	No	N/A
Laboratory has two exits.	____	____	____
The emergency exit procedure is posted.	____	____	____
A general alarm system is provided for the entire building.	____	____	____
Individual student work stations are provided. The number of students does not exceed the number of work stations. (A maximum of 24 students are in any one laboratory classroom.)	____	____	____
Work surfaces are made of nonporous and chemical-resistant materials.	____	____	____
Safety rules are posted in the laboratory.	____	____	____
Material Safety Data Sheets are available for all hazardous chemicals stored and used in the laboratory.	____	____	____
A master gas cut-off switch is easily accessible to the teacher.	____	____	____
A master electric cut-off switch is easily accessible to the teacher.	____	____	____
Aisles are wide enough so that teachers and students can move freely without interfering with others' work.	____	____	____
A key is provided to lock the laboratory-classroom when not in use.	____	____	____
Separate storage area is provided for large containers of dangerous reagents; e.g., five-liter bottles of concentrated acid.	____	____	____
An adequate room ventilation system is provided in all laboratories using volatile substances. (A floor to ceiling forced air ventilation system is in place.)	____	____	____
Household type refrigerators are not used for chemical storage.	____	____	____

	Yes	No	N/A
A safety shower is available in all chemistry laboratories.	_____	_____	_____
A safety shower is available in all physical science laboratories.	_____	_____	_____
Facilities for flushing the eyes are available.	_____	_____	_____
Multipurpose (class A, B, and C) fire extinguishers are easily accessible to teachers and students.	_____	_____	_____
Rubber or plastic gloves are available.	_____	_____	_____
Approved eye protection devices are available for each student.	_____	_____	_____
Approved respiratory protection devices are provided to filter dust and organic vapor.	_____	_____	_____
Approved laboratory aprons are available for each student.	_____	_____	_____
Approved fire blankets are available in each laboratory.	_____	_____	_____
Spill control kits/sand buckets are available in each laboratory.	_____	_____	_____
Heat resistant gloves are available.	_____	_____	_____
Operational fume hoods are provided in laboratories where noxious or toxic chemical fumes are used.	_____	_____	_____
Fume hoods have operational safety-glass access windows.	_____	_____	_____
Fume hood is clear and clean (not used as a storage area).	_____	_____	_____
Earthenware (ceramic) waste jars for broken glass are provided in each laboratory.	_____	_____	_____
Floor is clear of refuse and equipment.	_____	_____	_____
No refuse is left in laboratory overnight.	_____	_____	_____
A container of an acid neutralizer is available in chemistry laboratories.	_____	_____	_____
All electrical outlets provide a grounded connection.	_____	_____	_____
All electrical equipment and appliances are properly grounded.	_____	_____	_____
Sufficient, properly installed electrical outlets are provided so as to eliminate the use of extension cords.	_____	_____	_____

Section II: Storeroom

Safety Factor	Yes	No	N/A
The storeroom is well lighted, has no blind alleys, and is continuously forced-ventilated.	_____	_____	_____
There is adequate space in the storeroom to provide storage for all chemicals and supplies.	_____	_____	_____
Chemicals are stored based on the chemical properties and the particular hazards of the substances rather than on simply the alphabetical order of the chemical names. Organic chemicals are separated from inorganic chemicals. Flammables are stored in special fire-proof cabinets.	_____	_____	_____
All reagent chemicals are properly labeled according to the labeling requirements of the Texas Hazard Communication Act.	_____	_____	_____
All unlabeled reagents are disposed of properly.	_____	_____	_____
Incompatible chemicals such as oxidizing and reducing agents that might react together are stored separately.	_____	_____	_____
Volatile liquids are stored far away from heat sources and electrical switches.	_____	_____	_____
Dangerous chemicals used in the laboratory are kept in small quantities.	_____	_____	_____
Old and deteriorating chemicals are to be disposed of properly.	_____	_____	_____
Large containers of chemicals are stored near the floor.	_____	_____	_____
A multipurpose (class A, B, and C) fire extinguisher is located in each storeroom.	_____	_____	_____
Protective gloves are available for transferring hazardous chemicals.	_____	_____	_____
Different storage areas are provided to separate chemicals from delicate equipment; e.g., meters, microscopes.	_____	_____	_____
Metal shelf supports are inspected frequently for signs of chemical corrosion.	_____	_____	_____
A cart is provided to transport materials from storeroom to laboratory.	_____	_____	_____
A specialized storage area is supplied to store glass tubing.	_____	_____	_____

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, U.S. Department of Education.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.

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